DISCOVERY

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Edited by L. Russell Muirhead

Volume XVIII

JANUARY TO DECEMBER

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January 1937 One Shilling

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DISCOVERY

A Monthly Popular Journal of Knowledge

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Notes of the Month.

PAGEANTRY and display stand prominent in the programme of events for 1937. London will be honoured by the spectacle of the Coronation, a ceremony in which the colour of tradition and history mingles with the splendour of present-day pomp; while Paris is to be the scene of an International Exhibition such as the world has never beheld. With its magnificently planned riverside boulevards and squares, Paris affords the exhibition-architect a field of unique opportunity; and this year the natural advantages of the site will be supplemented by the wonders of modern illumination. Our illustration on the following page shows a model of the slope leading up from the Pont d'Iéna to the new Trocadero. The familiar towers and bulging apse of the old building are gone—vanished like the Crystal Palace, though, in this case, by intention—and a plain colonnade replaces them. Preceding this is a fountain, which will be a fountain of light during the Exhibition, to serve as a pendant to the brilliant lighting effects of the Eiffel Tower opposite.

* * * * *

The University of London Press has recently published an Illustrated Historical Time Chart of Elementary Mathematics for senior and secondary schools, training colleges and universities, by E. J. Edwards, M.C., in five sections, on thick varnished cardboard, priced at 21s. the set. The purpose of this chart is to present in a clear, concise and attractive form the continuous story of the main developments of the various branches of elementary mathematics from its earliest, crude beginnings in primitive times down to the invention of the Calculus by Newton and Leibnitz at the end of the 17th century. The careful arrangement of the material enables the main movements and stages in the growth of the subject to be traced quite easily, and the names of the great mathematicians of the world can be seen at a glance. The chart will be invaluable to the teacher who seeks to enhance the educational value of his lessons by incidental references to the history of the topics under consideration. The five sections can be handled separately or hung in chronological order on the class-room wall, the whole chart being then approximately 12 ft. 6 ins. long and 1 ft. 10 ins. deep.

* * * * *

One of the healthiest symptoms of the state of modern science is the efficiency of the bulletins of school societies dealing with various aspects of natural science, which reach us from time to time. To-day we have before us the seventh annual report of the Eton College Natural History Society and No. 3 of the Field Club Journal and Museum Bulletin of Bedford Modern School. The aims of the two publications are rather different, but they are both well produced and clearly printed and illustrated. The Eton report adheres closely to its subject: a list of the expeditions made by the Society shows good judgment in the choice of a varied programme; the work on the Bird Sanctuary is strenuous and enthusiastic; and the prize essay in the Society's summer holiday competition, entitled *Some Experiments with Hormones*, by G. Gordon, is a model of lucidity and scientific method.

* * * * *

The Bedford journal and bulletin covers a wider field, though it is smaller in format. Local archæology and ethnology, as well as natural history, are dealt with; and the survey of Stevington parish, which is being carried on in the approved Le Play Society manner, linking history with geography and natural phenomena, is a work of importance in itself. We shall be interested to hear whether any trace of a possible Stevington

Castle comes to light on future investigation; and further information on the discoveries made at the Romano-British site at Bletsoe will be welcome. The natural science reports contain less interesting material, but it is evident that they are proceeding on the right lines.

* * * *

Rumours of the discovery in East Africa of an authentic example of the Nandi Bear, hitherto regarded as a mythical beast, led us to apply to Dr. Van Someren, Curator of the Coryndon Memorial Museum at Nairobi, for the actual facts. Dr. Van Someren's reply does nothing to substantiate the existence of the alleged new animal; quite the reverse. And herewith we quote him on the subject, from an article in the *East African Standard* on the "Missing Lynx," his apt description of the animal that actually *was* discovered.

* * * *

"Considerable prominence has been given to the association of the so-called Nandi Bear with the specimen of the new (that is new to Kenya) animal which has been brought to light recently. Briefly, the facts are as follows: This new Kenya beast belongs to the family of cats, and to that section of medium-sized short-tailed, long-legged species known to science as *Felis* (*Profelis*) *aurata*, commonly called 'Tiger Cats.' Its nearest relatives are *F. temmincki* of Asia, and *F. pardalis* of South America. The newly-discovered Kenya specimen is rufous, with darker line on mid-dorsum; slight indication of banding on tail, slight spotting on sides; and large blackish spots on flanks and ventral surface; hair on dorsum of shoulders directed forward to in front of ears, and marginal crest extending to the ears and then forward below the eyes; total length 1,280 mm." Dr. Van Someren goes on to note that the Wandarobo name "keret" or "kerit" is applied to the lynx or caracal as well as to the mythical "Nandi Bear," a fact which no doubt gave rise to the original misapprehension. However, the animal which was presented to example of this plentiful West African species to have the museum is of great scientific interest, as the first been found in East Africa.

[By courtesy of the Editor of "La Science et la Vie"

View of the new Trocadero in Paris, looking upwards from the Seine, with the luminous fountain for the Exhibition in the centre.

* * * *

A new material called "isyntha," for insulating tubes, wires, etc., is reported in *Helios*, the electrical trade journal of Leipzig, as having been evolved to meet the scarcity in Germany of suitable material of home production. It is fireproof and unaffected by acids or oils. Heating to a temperature of 172° F. for 30 days caused no change in the material, and it withstood immersion in various acids and in a solution of caustic soda without showing any external change or loss of weight. Tubes made from "isyntha" are free from seams and woven layers, and during a test with an oscillating crank gear it was not until more than a million bends had been made that a crack appeared in the material.

* * * *

The recent discovery of coffins containing detached human skeletons in a cave in the Southern Shan States, by Dr. V. P. Sondhi of the Geological Survey of India, is discussed in a recent number of *Science and Culture*, by Dr. J. K. Bose. It appears that these burials are those of an unknown people who "kept well out of sight of the civilised men and away from the latter's habitations and they approached the villages and fields at night and decamped with paddy." These characteristics are found to-day amongst some of the tribes of Manipur who live in the secluded spurs of the hills and away from other human contact. The unknown people are also reported to have used crude earthen pots and wooden tools, but specimens have not yet come to hand. Indeed, it is the absence of utensils near the graves that inclines Dr. Bose to the belief that these coffins mark a place of secondary burial, carried out a year or so after the primary burial.

Physical Research in the Arctic

By A. R. Glen and R. A. Hamilton.

Oxford University Arctic Expedition, 1935-36.

1.—Ionosphere, Ozone and Magnetic Research

Exploration beyond the purely geographical has become the main feature of Arctic work nowadays, and the scientific results of the Oxford University Expedition to North-East Land bid fair to be of the highest importance. With the expansion of the use of wireless waves, the properties of the reflecting ionosphere layer have become especially interesting, and the Expedition has brought back extensive records, of which the final result has yet to be assessed.

THE Oxford University Arctic Expedition has returned from its investigations in North-East Land after an excellent season, in which the absence of casualties to the members of the party was as welcome a feature as the very large measure of success with which the scientific programme was carried out. This part of the programme was fully discussed in an article written before the departure of the expedition and published in DISCOVERY in March, 1935. The expedition returned to England in mid-September, 1936, after fourteen months in North-East Land, during which period practically the whole of the scientific programme has been accomplished. The personnel was made up as follows: A. R. Glen (leader and glacialogist), N. A. C. Croft (second-in-command and photographer), A. Dunlop-Mackenzie (organiser and surveyor), A. S. T. Godfrey (surveyor), A. B. Whatman (in charge of radio research), R. A. Hamilton (physicist), R. Moss (physicist), T. W. Wright (surveyor), D. B. Keith (biologist), K. J. Bengtssen (trapper).

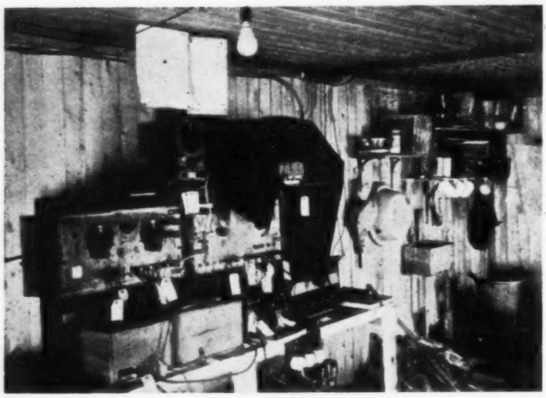
The base hut in Brandy Bay in spring, with the wireless and ionospheric research masts behind.

Hamilton working with the day spectrograph for measuring the atmospheric ozone.

The base hut was successfully established at the entrance to Brandy Bay, on a small promontory below some basalt cliffs. Originally it had been intended that Rijps Bay should be the site of the base, but heavy ice on the north coast made it appear imprudent to continue farther east without risk of an excessive loss of time. In fact the site chosen proved to be infinitely preferable to any possible site in Rijps Bay. By the end of August, 1935, the base hut had been built and the greater part of the scientific equipment set up.

Part of the scientific programme was the research on the ionosphere—that region in the upper atmosphere where free electrons reflect wireless waves. Thus by successive reflections there and at the earth's surface, radio signals can travel round the world and not be lost in space as would be the case if the ionosphere did not exist. The transmitter was specially built for the expedition and was housed in a small hut—the "ionosphere hut"—80 yards from the base hut. The receiver, part of which was kindly lent by the Radio Research Station, Slough, was kept in the living room of the base hut.

The transmitter sends out short pulses of electromagnetic energy each lasting 200 millionths of a second at a rate of 50 pulses a second. These pulses are radiated in all directions: some reach the receiver by travelling



The ionosphere research receiver in the base hut with the cathode ray oscillograph system above.

direct along the ground, others by travelling high up into the atmosphere, where they are reflected downwards by one or more of the conducting layers. The output of the receiver is connected to one plate of a cathode ray oscillograph. This is an instrument in which a fast beam of electrons passes between deflecting plates and impinges on a screen, where it produces a spot of light. Each time a pulse is sent out from the transmitter the spot of light is made to move horizontally across the screen, the direct pulse when received causes the spot to be moved vertically for an instant, and when a little later the reflected pulse is received again, the spot is moved vertically: the distance between the two vertical deflections is a measure of the difference of the time taken by the direct and the reflected pulse respectively to reach the receiver, and thus the height of the layer is calculated.

Two operators are needed for each run: one sits in the transmitting hut—this proved a favourite pastime among all members of the expedition—and the other operates the receiver. The transmitter is set on a given frequency and its operator rings the telephone bell. The receiver operator turns the receiver until the echoes appear, he snaps the shutter of the camera which takes a photograph of the screen of the oscillograph on a strip of bromide paper on a drum, he turns a wheel which rotates the drum so that it is ready for the next picture, and then he rings the bell, signifying that he has finished with that frequency. The transmitter operator then sets on the next frequency, rings his bell and the whole process is repeated. The frequency is thus varied in steps of 0.1 megacycles per second from 1.5 mc/s. until the frequency is so high that no echoes are obtained, and the pulses go out into space without reflection. The receiver operator then rings his bell five times and the relieved transmitter operator returns to the warmth of the main hut. A run such as this was taken every day at local noon; every fortnight on International Days, runs were taken every two hours for twenty-four hours. Special runs were made during the solar eclipse, and when auroræ were directly overhead. In addition, continuous runs were made for twenty-four hours: the transmitter is set on a fixed frequency, a clock is made to drive the camera drum and the echo pattern is photographed continuously, thus showing how the heights of the reflecting layers vary with time. It will be a very long time before the results are worked up, for a preliminary inspection shows that they are important and unexpected. Their importance is shown by the fact that already plans are being made for another expedition to continue research in the atmosphere.

The object of the auroral observations was the determination of the direction of the arcs; in any place in the world the arcs tend to form in a certain direction, and this direction is characteristic of the place on the earth. Two cameras separated by a base of some twenty miles, and taking simultaneous parallactic photographs are really necessary to determine the direction and height of the auroral arc, but quite a good determination of the direction of the arcs can be obtained by taking single photographs with one camera. At the Auroral Observatory, Tromsö, the photographs were projected by means of a lantern on to a white sheet of paper, the contours of the auroræ were drawn up and the stars marked off. Three stars on the drawing are needed and their height and azimuth are computed. The heights and azimuths of a number of points selected along the lower border of the arcs are now determined by means of graphs, or "nets"; the white sheet of paper is laid on a suitable "net" so that the heights and azimuths of the selected stars fit in with the curves on the net, and so the heights and azimuths of a number of points selected along the auroral border is read off directly. Assuming the height of the lower border to be 100 km. the position and direction of the arc can be computed. The direction of sixteen arcs were thus determined. In addition, observations of the auroræ were made at each hour, as the presence of auroræ affect the ionosphere results very considerably.

Sun-spectrograph Broken

It was planned to measure the amount of ozone in the upper atmosphere throughout the year, using the Dobson spectrograph on the sun during the summer, and another spectrograph on the Pole Star during the winter. Unfortunately, the sun-spectrograph was broken during the first month of the expedition, and it proved impossible to repair it. The Pole Star spectrograph, usually referred to as "Polaris," can be used

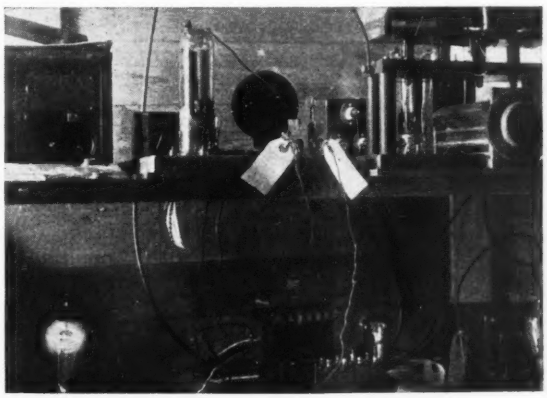
only when the moon is between its last and first quarter, and when the weather is good. Altogether only 80 photographs could be taken, but these, even when the worst ones are discarded, will be sufficient to determine the total amount of ozone and its variation throughout the winter—a problem of very great importance. The plates must be measured up carefully on a photometer; this is a tedious affair and will take a long time. Owing to the fogging of the plates by auroral light, it may be necessary to set up the spectrograph in Oxford and by artificially fogging the plates determine what correction must be applied to compensate for the auroral fogging.

The spectrograph consists of a quartz prism, a quartz lens forming a narrow spectrum of the Pole Star 0.15 mm. wide and about 4 cm. long on an isochromatic plate. The ozone in the upper atmosphere partially absorbs ultra-violet light from the Pole Star and by measuring, on the plate, the ratio of the intensity of the ultra-violet in the band to the intensity just outside the band the thickness of the ozone layer can be determined. The instrument rests at one point A on a small steel ball on an iron stand, allowing rotation in all directions. At another point B it is suspended by a string passing over a pulley in the roof with a weight at the other end, and another point C rests on a knob C on a dial which is driven by a clock so that the direction AC points in the direction of the pole star. (It is not a simple instrument to use: a concrete base must be used for the stand, the focusing must be such that the width of the spectrum does not vary appreciably from 0.15 mm. and the clock, working at a temperature of perhaps -30° F., must drive the spectrograph very accurately.)

The Capricious "Benndorf"

Research on atmospheric electricity had been planned, the special investigation being the connection between the aurora and the atmospheric electric gradient at the earth's surface; observers have obtained discordant results on this point. For this a Benndorf self-registering electrometer was kindly lent by the Meteorological Office, who also lent apparatus for the stretched wire experiment when the electric gradient is measured absolutely. The latter experiment, however, was never carried out, for one of the pairs of fibres of the Wulff electrometer was broken by being raised to too high a potential during a drift snow storm, and the spare pair did not survive the journey to North-East Land. The capriciousness of the Benndorf is well known and the instrument certainly lived up to its reputation; for weeks on end it went wrong every day, each time due to a different cause, until it was finally mastered. Soon after that, however, drift storms began, and the instrument was continually being snowed over, as no more suitable place than the rather porous porch of the base hut could be found for it. It proved quite impossible to keep it free of snow for a sufficient length of time for its record to be of any value, and the investigation was abandoned.

This proved to be small loss to the expedition: a simple magnetometer had been taken, and the direction of the earth's magnetic field could be read, so that we could know when a magnetic storm was in progress, but this instrument was now taken to bits and with it and the Benndorf an excellent magnetograph was constructed. During the winter this functioned very well in the bedroom, where each minute the relays with a loud crash annoyed the would-be sleepers, but at the same time recorded on a moving piece of paper the direction of the earth's field. The position was not ideal, however, for it was knocked over several times by sledges brought in for repair, and occasionally when the trace was examined no marks were found on it, and it was found that the needle had moved off the scale owing to some careless person's leaving a hammer on the box on which the instrument stood. In the summer when the "Polaris" spectrograph was taken down, the magnetograph was set up in the ionosphere hut where it functioned excellently, and its traces, showing the magnetic variations due to electric currents in the upper atmosphere, are proving invaluable when examined in connection with the ionosphere results. This magnetograph was the most valuable result of abandoning the three instruments, but it was only one of many. When making anything new at the Base it became an established fact that for success it must include some part of the Benndorf, and its accessories were used in a dog harness, dog whip, door



The ionosphere transmitter in the small hut 80 metres from the base hut. The transmitter sends out 50 pulses per second, which after travelling to the ionised layers are reflected and received by the receiver in the base hut.

handle, meridian mark for the astronomical theodolite, a spade, and a tide gauge.

Routine meteorological readings were taken thrice daily for a complete year at the base, for nine months at the central ice-cap station, and for four winter months at the northern ice-cap station, and additional readings were taken for three months at Murchison Bay in the summer and on all sledging journeys. The winter proved to be not as severe as it was expected, for February and March were the only months in which the average temperature at sea level was below zero Fahrenheit. The fierce gales were not as frequent as was anticipated, but the wind at the base averaged about 20 m.p.h., which with drifting snow made the conditions seem worse than they were in fact, and also hindered travel very considerably. The cloudiness was very great, except in February and March, and from the middle of May till the end of June the sun was scarcely ever seen. Strong Föhn winds during the winter often brought warm weather; the bay ice which in December seemed firm and strong was blown out in a spell of warm weather in January, and in mid February on one day the temperature rose from 0° F. to 32° F. the next, only to fall again to –2° F. on the next morning, causing trouble in starting the engine which had been rested during the warm weather. For eight days in June the temperature never rose above 32° F. When all the meteorological readings are examined together, they should give information as to the conditions on and around a small ice cap.

Before the expedition visited North-East Land the country was largely unknown. The survey programme was much interfered with by the predominantly bad weather, but the whole programme was eventually carried out, although the final survey party returned to the base only three days before the ship arrived to take the expedition back to England. The whole of the north coast was mapped, the new survey showing it to be very different from what had been imagined; the east coast and south coast were also surveyed as well as the greater part of the interior. The country as a whole must now be one of the best mapped lands in the Arctic.

For long there had been considerable doubt as to the existence of a large fjord which had been reported by Nordenskiöld in 1873, on the south-east coast. This bay has appeared on and disappeared from maps in the most picturesque manner and it is now with the deepest regret that it must be finally erased. Croft and Glen sledged along the east and south coasts in June of this year, and in addition to the discovery of the non-existence of Nordenskiöld fjord, a few other finds of interest were made. Ice cliffs form the greater part of the east coast but they are broken at several points by outcrops of land, some of which had not been reported before. On the south coast the ice cliffs do not continue nearly as far west as have been thought.

Satisfactory too was the high standard of health enjoyed by every member. No doctor had been taken, as the expedition doctor fell ill shortly before the time of departure and it was not possible to find a substitute. Fortunately there was no illness and never the slightest indication of scurvy, thanks to the excellence of the Redoxon Vitamin C tablets made by Messrs. Hoffmann La Roche.

British Association.

The Annual Meeting of the British Association will be held next year in Nottingham, from September 1st to 8th, under the presidency of Sir Edward Poulton, F.R.S. The following sectional presidents have been appointed: Section A (Mathematical and Physical Sciences), Dr. G. W. C. Kaye; B (Chemistry), Dr. F. L. Pyman, F.R.S.; C (Geology), Professor L. J. Wills; D (Zoology), Professor F. A. E. Crew; E (Geography), Professor C. B. Fawcett; F. (Economics), Professor P. Sargant Florence; G (Engineering), Sir Alexander Gibb, G.B.E., C.B., F.R.S.; H (Anthropology), Dr. J. H. Hutton, C.I.E.; I (Physiology), Dr. E. P. Poulton; J (Psychology), Dr. Mary Collins; K (Botany), Professor E. J. Salisbury, F.R.S.; L (Education), Mr. H. G. Wells; M(Agriculture), Mr. J. M. Caie.

A New Mountain Ascent.

It is reported in *The Times* that Mount Carstens, a 16,000-foot peak in Dutch New Guinea, has been ascended, for the first time, by Dr. A. H. Colijn, son of the Netherlands Prime Minister. A preliminary air reconnaissance enabled Dr. Colijn to succeed where Dr. Wollaston, an English explorer, failed in 1912.

Dr. Brereton's French Prize.

We are delighted to take this opportunity of congratulating Dr. Cloudesley Brereton, one of DISCOVERY's most loyal supporters, on the receipt of an award of 15,000 francs for his book, *France*, this being one of the International Tourist Prizes recently founded for books on France written by foreigners and published since January 1st, 1935.

Among the Dyaks of Borneo.

By G. J. D. Walters.

Their custom of head-hunting has given the Dyaks a reputation for bloodthirstiness that they scarcely deserve. They are, in fact, an intelligent and adaptable people; and our author's account of a journey through their country in the little-known interior of Borneo gives an impression of hospitality willingly given and gladly received.

In Borneo there is an interesting race of people whose natural instinct of head-hunting has brought them considerable notoriety, although the country they inhabit in the northern half of this vast equatorial island is seldom visited. Less than a hundred years ago, the Dyak tribes waged constant warfare by raiding each other for heads; but their warlike tendencies have been largely suppressed under European rule. The heads captured by the tribesmen, however, are still retained in their houses, and the head-hunting instinct is almost as strong as ever. As Officer in charge of an up-country district, I had the opportunity of visiting these primitive people, and it is of a trip to the headwaters of the Sadong river that I now write.

A Dyak in pensive mood.

Near the estuary the population is mainly Malay, but the inhabitants inland are divided into two distinct races, known as the Sea and Land Dyaks; the former, so called because they live nearer the coast, are a cheerful, energetic and enterprising race; while the latter are a quiet and retiring folk, and seldom leave their villages in the mountains. Both types in many ways resemble the New Zealand Maoris and are very hospitable; indeed, lack of hospitality is regarded as a punishable offence.

The object of this expedition was to penetrate the unexplored regions of the interior, where many remote villages have never yet been visited by a white man. The start was made early one morning by motor launch from the Government Station, where the river is about a quarter of a mile wide and sweeps through the flat swampy country near the coast. I was accompanied by two Malay policemen and my Chinese cook, and during the first day there was little to do but watch the endless panorama of tall jungle trees with mangroves and nipa palms fringing their base at the water edge. Occasionally we passed native canoes piled high with heaps of fruit and merchandise; for here the rivers are the main highways, and overland journeys are seldom undertaken owing to the difficulty of negotiating the dense tropical forest. At times the skyline of jungle was broken by spacious padi fields, or the orderly rows of rubber trees in a native garden. Early that afternoon we reached the small Malay village of Gedong, where the night was spent.

Next morning, having dispensed with the launch, we resumed the journey up-river in a native canoe manned by eight Dyak paddlers. Beneath its stuffy awning a rather uncomfortable day was passed; but towards evening a Dyak village suddenly came into view round a bend of the river. At first sight, a Dyak village presents an amazing spectacle, for it consists of one huge communal house in which the whole population is accommodated, the average house being some 600 ft. long by about 50 ft. wide, and raised on piles 10 ft. from the ground. In this structure the villagers, who generally number several hundreds, dwell together in perfect harmony. As we drew in towards the bank, a large crowd of Dyaks gathered excitedly beside the river and our arrival appeared to cause a tremendous sensation. Having succeeded in clambering ashore up the slippery log which constitutes the landing stage, I was welcomed by the headman who solemnly shook my hand and then proceeded to lead the way towards the house, with a mass of men, women, and children following closely

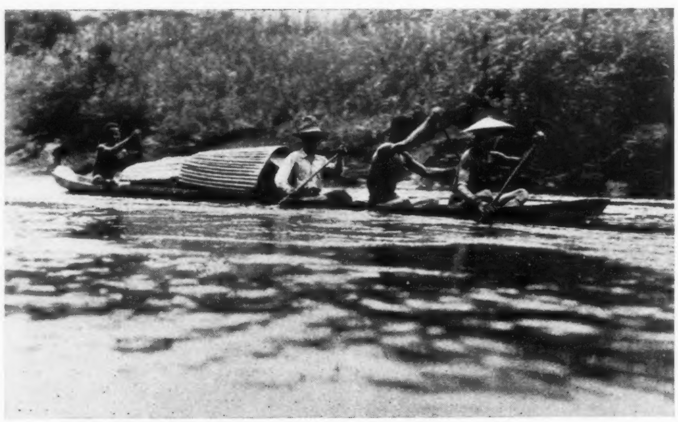
in our wake. Most of the people were scantily clad. The men wore loin cloths and the women short skirts. The only adornment of the latter is their brass rings set close together round their waists and legs. Some of the men, however, sported an amazing assortment of European apparel, with perhaps a small hat surmounting their long black hair and pendulous ear lobes; although their appearance is quite spoilt by such clothes which conceal their magnificent physique.

We entered the house by climbing a notched pole to the raised floor, above which we emerged into the village "high street" or common meeting place, a huge enclosed verandah occupying the whole front half of the building. The rear portion of the house is divided up into equal sized rooms, each with a door leading on to the "high street"; one family occupies each room and the whole establishment is kept very neat and clean. Every member of the village helps to build the house, for which nothing is imported, all timber and thatching being obtained from the jungle. Although the building is substantially made, the Sea Dyaks dismantle their houses every few years and re-erect them in another part of the jungle, so that their crops may flourish in the fresh soil.

Throughout this trip, which lasted three weeks, almost every night was spent in a Dyak village, where numerous troubles and disputes were settled. The cases were invariably heard in public on the main verandah, although the Dyaks generally endeavoured to terminate the proceedings as rapidly as possible in order to start the festivities of the evening. These entertainments frequently went on all night, to the accompaniment of syncopated "music" provided by a selection of brass gongs which the children of the tribe beat with great vigour. Although both men and women perform picturesque dances which mainly emulate jungle birds and animals, the most popular dance of these people is for two warriors to go through a mock fight in which their flashing swords make an impressive display. When I had seen enough, I retired to the room which was always put at my disposal; but before going to sleep I sometimes received a nasty shock on perceiving that what at first appeared to be a bunch of onions hanging up in the roof was really a collection of human skulls! At dawn, also, one's slumbers are rudely disturbed by an uproar from the farmyard of pigs, fowls, and other domestic animals which live below the house.

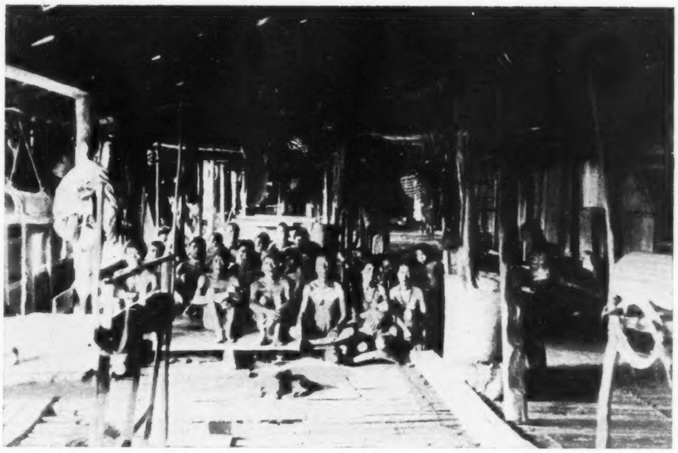
Daybreak finds a Dyak house deserted by all the able-bodied men, who have set out on their daily work. Each has an allotted task; some tend the padi fields, while others hunt wild game or go in search of jungle produce. The old people and women remain behind to perform the domestic tasks, and it is the latter's duty to keep the house supplied with water, which they carry up from the river in stems of bamboo slung on their backs. Although the headman invariably pressed me to prolong my visit, I generally managed to be on my way up-river soon after sunrise. For the first three days of the journey, where the river was tidal, crocodiles were frequently seen. These brutes are a constant menace to the Dyaks, and children playing beside the water are often caught unawares. Sometimes these reptiles are seen lying on the banks, but generally they remain submerged, the only indication of their presence being the upper part of the head, which closely resembles a floating log, showing just above the surface.

When the hill country of the interior was reached on the fourth day, the river became a shallow stream, some thirty yards wide, with a strong current flowing downstream. Here it was necessary to transfer to a narrow canoe about thirty feet long, made in one piece from the trunk of a tree. This craft was manned by a crew of ten Dyaks who used punt poles instead of paddles, the whole crew standing up in the boat on each side and keeping time together. Farther upstream were numerous rapids on which the boat frequently went hard aground. On these occasions, the Dyaks promptly jumped into the river and dragged the canoe on into the deeper water beyond. Despite these difficulties, we made good progress and eventually arrived at a Land Dyak village, where the inhabitants were even more friendly than the Sea Dyaks.



Native canoe with only about two inches of free-board. In Borneo, rivers are the main highways of travel.

Many villages in this mountainous region cannot be reached by boat, so having persuaded the riverside Dyaks to carry my baggage and act as guides, I set out through the jungle to visit these remote people. Although there was apparently no vestige of a track in the jungle, the man who led the way strode ahead without hesitation. Visibility was entirely confined to the mass of tall trees and undergrowth through which the Dyaks frequently had to cut a path with their swords. On the hill tops, however, the going was much easier. Here the columns of enormous trees tower up to a great height, their branches interlacing



Interior of a Dyak long house. The villagers are sitting in what is equivalent to their " high street." On the right are doors leading into separate rooms where each family has its private dwelling.

Felling a tree in thick jungle. The woodman stands some fifteen feet above ground-level so as to hew through the trunk above its spreading root-branches.

far overhead like the roof of a gigantic cathedral, while the ground beneath is practically clear of undergrowth. Sometimes we would emerge into an open clearing or padi field affording a magnificent glimpse of jungle-clad mountains with foaming cascades cleaving the valleys. Many deep ravines were encountered, each spanned by a huge tree trunk felled to bridge the gap. Although the upper surface of a tree trunk " bridge " is generally slippery, with no sort of foothold and probably a drop of several hundred feet below, the Dyaks walk across easily enough in bare feet ; but in shoes it is rather a hazardous undertaking.

While travelling overland, the sound of a gong being beaten in a peculiar rhythmic manner was frequently heard echoing amongst the hills. These were the signal gongs by which the Dyaks relay messages on from one village to another. Evidently news of my approach was transmitted by this means, for long before any sign of human habitation was reached we were invariably greeted by a party of Dyaks who had come out to conduct us in to their village. Like the Sea Dyaks, these people are pagans, and their daily lives are largely controlled by animistic beliefs in which certain wild birds, especially the hawk, play an important part. These birds are graded in importance, the omens being determined by the position in which the bird is seen and the direction of its flight. When a bad omen is seen by Dyaks who have set out on an expedition, they invariably return home where they wait until the auspices are more favourable.

Although sago, maize, tapioca, and sweet potatoes are cultivated by the Dyaks, their principal foodstuff is padi, or rice in husk. The crops are raised in the hills and lowlands by the same method. In a tract of jungle, perhaps a mile square, all trees are felled and then burned as completely as possible, so that the ashes enrich the soil. This ground is used for one season only. Two or three years later, the young jungle, which grows amazingly fast, is again cut down and burned, and another crop raised. This process is repeated three or four times, but after this the land becomes very inferior and is abandoned, fresh jungle being then resorted to and treated in the same way. Hillside jungle

is disposed of by cutting half through the trunk of every large tree inside a V-shaped area, the apex of the V being at the highest point on the hill. One or two of the largest trees at the apex are then carefully selected and cut so as to fall downhill. These giants crash on to the trees standing immediately below, which in turn fall against their neighbours, the avalanche descending with increasing momentum in an ever-widening sweep.

Towards the end of the trip, exceptionally violent thunderstorms accompanied by great downpours of rain were experienced, transforming peaceful mountain streams into raging torrents. Although the Dyaks had taken three days to pole the canoe, in which I travelled, to the headwaters of the river, the same journey down-stream took us only four hours. This time, paddles were used to control the craft which was swept along at great speed by the surging waters. Many times it looked as though we should be dashed to pieces on the rapids, but on each occasion the steersman averted disaster at the last second by a skilful turn of his paddle and eventually brought us in safety to the calm waters of the tidal river.

From Torch to Candle

By F. W. Robins, F.R.G.S.

In 1935 Mr. Robins told the story of the Lamp to readers of DISCOVERY. *The history of the development of another form of illumination is an equally important record of the progress of civilisation.*

IT would not have been long after primitive man had discovered the way to make a domestic fire when he first found the way to create a portable light; the casual taking up of a piece of burning wood would have suggested the carrying of an offshoot from the communal fire into the darkness, to keep the evil spirits away and give that extra courage that man, for all his present-day sophistication, still feels when he has a light. The torch antedated the most primitive form of lamp and even to-day there are races which have never had any other means of illumination than the burning brand.

Despite the fact that lamps of stone, shell and pottery had been in use long before, the Greeks, after the Mycenæan era, seem to have depended, until about the 7th century B.C., mainly on torches and braziers for lighting. Their torches were manufactured articles consisting of sticks of resinous wood tied together with rushes, papyrus or vine tendrils and treated with inflammable substances such as resin, pitch or wax; later, mixtures of such materials, including the resinous wood itself, were used as fillings to hollow cases of clay or metal. Evidence of the use of both forms of the torch is afforded by vase paintings, which also indicate the development of socketed torch holders for the hand.

In countries where wood of a suitable nature was plentiful, this remained the principal basis of the torch for a long time; where it was scarce some other material would be drawn into service sooner. An object depicted in certain Egyptian wall paintings of the New Kingdom period looks very like a torch of tallow or wax; it appears in two forms—one an almost diamond-shaped form and the other a cone or pyramid, either being mounted on a staff for carrying or standing and thus anticipating the principle of the "staff" torches of the middle ages. Along with these are to be seen "candles" or tapers of a twisted form suggesting thick lengths of rope treated with oil or fat, such as may have been used in the torch-holders of Tutankhamen's tomb. The isolated evidences of the use of a torch or taper in ancient Egypt suggest that it was in less common use than in Greece, where it not only served the more ordinary purposes of illumination but figured in rite and ceremony.

Rushlight and pine-splinter holders (Nos. 1, 2, 3, 5, 6, 9, 10) and pricket candlesticks (Nos. 4, 7, 8, 11, 12). No. 1 is a combined rushlight and dip holder; No. 10, a clay torch-holder, with holes for two torches and a handle. No. 7 is a type still in use in continental churches.

With the advent of the classical lamp about the 7th century B.C., the ordinary use of the torch in classical lands declined and its use by the Romans was mainly ceremonial. The Roman era

saw the introduction of a true candle; in addition to one resembling a torch, with a fibrous substance predominant, the Romans had a form closely resembling the modern candle, with a wick of a species of papyrus and wax or tallow as the main material. As with many other things, Roman candlesticks were nearer to the modern forms than were those of the Middle Ages; the majority of Roman candlesticks are socketed and include both the upright and flat or "dish" types, in metal (generally iron) and pottery — yet the socketed candlestick was unknown in madiæval Europe until the close of that era.

The incursions of northern barbarians brought the torch into prominence again and the pinewoods of the north must have provided thousands of natural torches for their rude huts. In the "dark ages," the physical darkness of the night had the torch as almost its sole enemy, notwithstanding Alfred's time candles and other references to candles of Saxon days. No wonder the "red cock" crew so often on the rooftrees of Saxon halls!

Some typical socket candlesticks, mostly of the 17th century or later. No. 6, however, is a copy of a wooden 15th century example, and No. 22 is a bronze type of the 15th or 16th century. No. 4 is an iron dockyard candlestick; No. 7 is an old English dip-holder; Nos. 13-14 show a folding type, for use in travelling; Nos. 19-20 are another travelling model; and No. 17 combines the socket and pricket methods of candle-holding.

In the records of the Middle Ages, the torch is almost inextricably mixed up with taper and candle, the word "taper," now usually regarded as meaning a thin candle, being constantly used to denote what was really a waxen torch or large candle. Some of the "torches" appear to be tall candles with wicks but there are regulations as to the offence of producing badly made links, which appear to have been torches pure and simple with a wax basis; candles, tapers, links and torches all appear in mediæval churchwardens' accounts.

In any case, the torch proper, whether composed of vegetable or animal matter or both, long remained in use in "civilised" lands. Scott gives a vivid description of the use of primitive torches in the Scottish highlands in *The Legend of Montrose* and states that the bog pine, found in the morasses, is so full of turpentine that it was frequently used instead of candles. The early New Englanders used pieces of resinous pitch-pine and stuck them between the stones of the fireplaces or in improvised holders; these were laid in stock for the winter and were used not only in the 17th century but up to the 20th in the cabins of negroes and "poor whites." As late as the Renaissance period, torches stuck in rings or holders were used for external illumination in Europe and there are examples of ornamental holders on the palaces of Florence; later, there are the "links" of Georgian England, lighting the sedan chair and its occupant to theatre, dance, and home.

In the forest areas of Northern Europe (including Scotland) the use of pine splinters for illumination was common and remained in vogue until recent times. Probably something of this kind was used by the Etruscans on their spiked candelabra. In modern times the holders have been iron uprights set on feet or on wooden stands, having metal loops or clips at the top for the insertion of the splinters; sometimes they were designed as wall brackets with a spike for sticking into the wall. Bavaria provides an interesting variation in the form of a grotesque human head in clay, into the open mouth of which the pine splinter was thrust, and this seems to have had its origin in the peasantry carrying lighted pine splinters in their own mouths when their hands were otherwise occupied.

Closely allied to the torch and pine splinter was the rushlight, used generally where resinous wood was scarce. Its actual date of origin is obscure; it may have antedated the candle. It was particularly a feature of

the English and Welsh countryside and consisted of a peeled rush having a strip of peel left for support, this strip incidentally having the added effect of the later plaited candle wick in curving the burnt material to one side and reducing the necessity for snuffing by bringing the carbonised point into contact with the air, a process assisted by the fact that the rushlight was held in a slanting position. The peeled rush was dipped in fat or grease to give it the combustible coating of a miniature torch or thin candle Rushlight holders (examples of which date from the 15th century onwards but are commonly of the 18th or early 19th) are generally in iron but might be (as not long ago in the north of England and in Wales) merely split sticks. Like the pine-splinter holders, they are uprights on feet or wood blocks, the former (usually tripod) earlier in type and connecting with the form of the earliest candlesticks. The grip end of the holder was first of all in the form of a pair of hinged pincers with a counterpoise weight on the free arm but many of the later specimens had the weight provided by a socket to hold a dip as an alternative to the rushlight.

The Pricket Candlestick

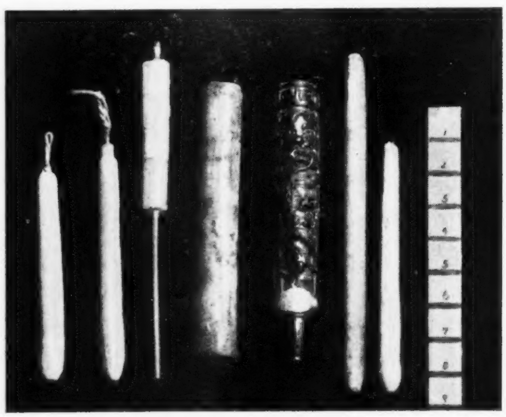
Long before Gilbert White was extolling the economy of the rushlight, the candle had established itself as a standard means of illumination and in this country it was by far the most prevalent means of illumination in the Middle Ages. Candles of wax were luxuries then and up to the early days of the 19th century the commoner candles (or dips) were made of tallow, the use of wax (in the form of beeswax) being confined almost entirely to the churches until the cheapening of wax in the 15th century increased its use. During the middle ages the pricket or spike candlestick was the one commonly used: in fact, after the Roman era, there is no trace of the socketed candlestick until the 14th century. This is probably connected with the prevalent use of the irregular dipped tallow candle, and the increased use of wax candles from the 15th century onwards goes hand in hand with the gradual supersession of the pricket by the socket (except in continental churches, where it holds on by force of tradition, and in the far East, where it still remains the prevalent type).

The method most commonly used for making tallow candles was dipping; this goes back to the Roman period and was the principal method used during the Middle Ages and long after. It was facilitated, in later days, by the use of a frame from which a number of wicks were suspended, thus enabling several "dips" to be manufactured at once; each layer of fat had to be allowed to set before the succeeding dipping took place. Wicks in home-made dips were commonly of rush but sometimes of textile materials and, where a frame was not used, rushes were often tied together in bunches of four, so that one wick was held between each pair of fingers, for dipping. After dipping, the candles were hung in a loft or cellar to harden and whiten.

Advent of Spermaceti

While the only alternative was the candle of beeswax (made by building up by hand or by "pouring" wax on the wicks—the latter process still in use for church candles of beeswax), the tallow candle held its own for common use until practically the end of the 18th century and in rural areas well into the 19th. Local manufacture has gone on until comparatively recently and tallow dips are still produced commercially for certain purposes, as where a large flame, not easily extinguishable by draughts, is required. Snuffless dips, composed of fatty acids and low-grade paraffin wax, with cotton wicks, have now taken the place of tallow dips for most purposes. The first departure from the centuries-old alternatives of tallow and beeswax came with the opening up of the sperm whale fishery in the 18th century. Spermaceti, a crystalline substance from the head of the sperm whale, came into use for candle-making near the end of that century and spermaceti candles, which are usually moulded in frames, are still the standard measure of artificial light.

The next step was the manufacture of stearine—fat from which the smoky and smelly glycerin has been extracted; this development was the outcome of



Some curious candles. From the left: a tallow dip; a paraffin wax dip from a Cornish tin mine; a 'dockyard candle' from South China; a tallow candle 300 years old; a candle copied from an old Manchurian pattern; and two more tallow dips, the first a so-called 'corpse candle.'

Chevreul's *Researches on the Constitution of Fatty Bodies*, published in 1823. Two years later (1825) the old twisted strands of cotton previously used as wicks (and still used in dips) were challenged by the plaited wick invented by Cambacérès, which sounded the death knell of the snuffers, since the automatic turning over of the burnt tip of the plaited wick exposed it to air and caused it to be self-snuffing. Stearine, at first produced from tallow and later from other fats (notably palm oil) burns with a clear smokeless flame, does not gutter and is especially suited for tropical use in that it does not bend when exposed to warmth. For these reasons, stearine is still used for candlemaking, but De Milly's discoveries were preceded and their utility lessened by the appearance of an entirely new material in 1850, after twenty years of experimental work—paraffin wax.

Paraffin candles, which form the vast majority of those now used in the British Isles, give a greater intensity of light than stearine but are more apt to bend in a warm atmosphere.

Making in moulds, which has taken the place of dipping as the usual method of candlemaking, is more suitable for use with textile wicks than with the fragile rush so often used in rural candlemaking. It is said to have been introduced by the Sieur de Brex of Paris in the 15th century and the small moulding appliances used from then on are the ancestors of the modern moulding machinery.

In China and Japan, candles are made on a bamboo core and of vegetable materials; the latter in general have been used in many places for candlemaking, especially in the Far East and the New World.

The Case for the Piltdown Jaw

By Alvan T. Marston

A great deal of extremely technical matter has been written concerning the provenance of the Piltdown Jaw, which has been associated with a human skull. Mr. Marston, whose combined dental and anthropological experience entitles him to speak with authority, here presents the proof, in plain language, that the jaw is in fact anthropoid, and does not belong to the skull.

It might be thought that since so much discussion had taken place in the last twenty years over the lower jaw of Piltdown, that the matter might be considered as closed, and that the Piltdown restorations embodying this chimpanzee-form of jaw in the features of Piltdown Man really represented the verdict passed and accepted by scientific opinion in general. This is not so. The Piltdown jaw is as assuredly the lower jaw of a fossil ape as the Piltdown skull bones are assuredly a part of the brain-case of a fossil man.

It is difficult to put into a few simple words in convincing form for the readers of Discovery, the evidence which will allow them to arrive at a judgment on a question which scientists have debated without establishing a conviction. For this judgment to be reached, three things are required:—

(*a*) an observation of the form of the human teeth and lower jaw.

(*b*) a clear idea of the actual Piltdown lower jaw and teeth;

(*c*) a general idea of the teeth and jaws of the apes.

We all have or have had teeth. It should therefore be simple to acquire a general idea of the forms of the human teeth and jaw. Briefly it may be noted that the teeth of man are arranged in the form of a somewhat horse-shoe shaped row which widens towards the back of the mouth; the teeth form a continuous row not broken, as in the dog or cat or apes, by a space between the canine teeth and the incisor teeth; also that the canine tooth is a straight-rooted, blunt-pointed tooth of which the crown, in the lower, does not project upwards and outside the upper teeth.

Now, so far as it has been possible to trace Man backwards in the way of actual fossils, Man has always had this human form of tooth arrangement. There are at least two forms of fossil man of much greater antiquity than Piltdown, namely the population of the Choukoutien cave near Pekin known as *Sinanthropus*, and the lower jaw of Heidelberg, in which the teeth have been preserved, and although in both of these the jaws and teeth are larger and more powerful than in modern man, they show the same basic plan. Casts of these specimens may be seen in many museums. Now these early human fossil types show that the teeth, then as now, form an uninterrupted series without a gap in the canine region, and all of the front teeth, canine and incisors alike, are worn down to the same level, and the canine is a straight-rooted tooth. You are asked to grasp the full importance of this. The teeth of modern man, and the teeth of the earliest known types of fossil man are fundamentally the same.

We will now go one stage further. If you will examine

the teeth of a child of three years of age, you will see that in the milk teeth the same horse-shoe shaped arrangement obtains; that the teeth present a continuous series not broken by a gap in the canine region, and that the lower canine does not bite outside the upper teeth. Now one of the *Sinanthropus* jaws is that of a child, and in it are preserved the lower canine and the first and second milk molars. These *Sinanthropus* milk teeth are of the same basic type and form as those of modern man. This fact is of even greater importance than the previous point established as regards the permanent teeth, and for the following reason: the milk teeth must be recognised as being vastly more primitive than the permanent teeth.

Tooth Formation

It is not to be expected that everyone should know the mechanism of tooth formation, but it can be known that the enamel which covers the crowns of the teeth is the hardest tissue in the body, that the very tip of the crown is formed first and that its formation proceeds onward from the tip downwards until the whole crown is formed and later the whole root. Once the crown is formed, the organ by which it is formed disappears, and thenceforward the shape of the crown cannot be altered in later life. The teeth thus differ from bone structures. Bones do alter their shape, they grow, thicken and lengthen, or become thin or frail, or bend, according to development, old age, or illness, but the crowns of the teeth cannot change within the life of the individual. The last half million years have not affected the basic design of the human tooth nor of the dental arch. The reason for this is to be sought in embryology. The teeth of the developing child can be shown by radiographs of a seven months old fœtus, and their formation begins much earlier, as early as the second month of uterine life.

We will now consider the teeth of the apes. For the same reason that the milk teeth of man must be considered as representing a more primitive condition than the permanent teeth, so must the milk teeth of the anthropoid apes be recognised as representing a more primitive condition than the permanent teeth of the anthropoids. Each new discovery of fossil man has been eagerly seized upon to be compared with the apes to see how near to the ape line the new discovery has brought us. Now if the milk teeth of the apes be examined, although they resemble the teeth of man much more closely than do the teeth of a cat or a dog, yet they differ, nevertheless, very markedly in detail from the teeth of man. The long muzzle of the dog with its spaced canines of which the lower crosses to bite outside the upper teeth is a very familiar picture and may serve to draw attention to the outstanding distinction between the general form of the jaw and the canine teeth of man and of the anthropoids.

Now, the anthropoid jaw, and the chimpanzee jaw in particular, instead of giving a horse-shoe shape to the tooth row, gives the dental arch the form of an elongated U-tube with parallel sides; with the molar cheek and canine teeth forming the sides of the U, and the incisor teeth, separated by a gap from the canines, forming the bottom of the U. The elongation that marks the muzzle of the dog is paralleled by the elongation that characterises every tooth in the tooth row of the ape and chimpanzee jaw.

Thus if the skull of a young chimpanzee which shows all of the milk teeth be compared with that of a human child, the second lower milk molar is seen to be less broad from side to side and its cusps charper and more cutting than the corresponding human tooth. The first lower milk molar is still more narrow, the outer cusp is sharpened and is shear-like, and the inner cusp is neither raised nor expanded as in the human first molar. Now, bear in mind that the milk molars of *Sinanthropus* are not like the milk molars of the ape or chimpanzee, but are like the teeth of modern man. The chimpanzee milk teeth and the human milk teeth clearly indicate that the chimpanzee and man were already on divergent lines of specialisation even at the very early stage of embryonic life at which these precise patterns of the teeth were laid down. Even as the milk teeth of fossil Man resemble the milk teeth of actual Man, so do the milk teeth of fossil Ape resemble the milk teeth of actual Ape and not the milk teeth of fossil Man. This affords one of the reasons among others for conluding that Man has not evolved from the gorilla-chimpanzee group; that Man never at any stage in his development nor in the development of any of his precursors, had teeth which resembled the teeth of the chimpanzee as closely as do the teeth of the Piltdown jaw.

Sufficient Evidence

It is probably widely known that the discovery which led up to the recognition of an early type of humanity in the Choukoutien cave before any skulls or human bones had been found, was that of a molar tooth. That tooth was sufficient to establish the early human qualities of the skull from which it had become separated. The Piltdown canine is sufficient to recognise that the skull from which it came was not human, that it possessed absolutely fundamental distinction from the human in respect of the manner in which it closed outside the upper teeth, from the curvature of its root and crown, from the cross section of its root, and from

the order of its eruption, but that in each of these respects, the canine tooth of the Piltdown jaw is definitely that of an Ape.

It will be necessary to become a little more technical in the explanation of these points of distinction, but I will endeavour to make it as simple as possible. Man is the only creature with the straight, blunt canine, vertically placed, and set in the tooth row without a gap between it and the adjacent teeth and not crossing over outside the upper teeth. The Piltdown canine is not straight. It exhibits not only a curvature in the root, but the crown is deflected outwards so that it bites outside the upper teeth. Its tongue surface shows the mark of wear from the upper tooth against which it crossed. It is known that such a form of tooth must have been accompanied in the upper jaw by a gap between the upper canine and the lateral incisor, and in brief that the upper jaw of the creature to which the Piltdown lower canine tooth belonged must have had the anthropoid elongated type of palate marked by a dividing line separating completely the bones of the upper jaw, the premaxilla from the maxilla. This anthropoid type of palate is never seen in Man at any stage in his development, for in Man these two bones fuse on the outer side of the jaw as soon as the developing child has reached the size of ten ordinary pin heads. That is another very important point to realise.

Next, take the cross section of the root: a very simple illustration will suffice to show the distinction between the human root and the chimpanzee root. Take a cigarette and lightly compress it between the fingers so that instead of being round it is oval. In Man the long diameter of the cross section is in the direction from the lip to the tongue. In Piltdown and in the Chimpanzee, the long diameter is in the opposite direction. Now it is possible to apply this simple test to any of the early fossil human forms, Sinanthropus, Heidelberg, Kanam, Spy, Neanderthal, etc., etc., and they all show the same characteristic. The Piltdown canine is not human: it is anthropoid.

The Order of Eruption

The next point which I wish to make is that of the order of the eruption of the teeth. This differs in Man and Ape. It has recently been demonstrated by Bennejeant (1936) that in the anthropoids the first permanent molar tooth erupts, then the incisors, then the second molar, then the premolars, and then the third molar at about the same time as the canine tooth. In Man, the order is different: the second molar erupts after the canines and premolars, and the third molar last of all. In the Piltdown jaw, the third molar is missing, but its socket is present, and it is possible to say it had erupted and that its root had formed. The root of the canine tooth in Piltdown, however, was not completed: its apex is still open, filled by a small particle of gravel, which shows that it did not follow the human order of eruption but the anthropoid order of eruption.

The Speech Muscles

Now these are simple facts, all too simply expressed. Close analysis of the patterns and dimensions of the Piltdown teeth, with arguments to explain the theories of these features, although not permissible in this article, nevertheless do show that the Piltdown teeth are not the teeth of Man but of an anthropoid. An analysis of the configuration and muscle markings of the Piltdown jaw shows as conclusively that neither in the function of the teeth nor in the function of the speech muscles can this jaw be correlated with the speech capacities of the Piltdown brain.

One of the main supports for considering the case proved in the past that the Piltdown jaw was human, was that it has been claimed that another molar tooth (a first left lower molar tooth), found in the same gravels some distance away, showed the same characters as the Piltdown type specimen. Analysis does not support this claim. The expanded posterior portion of this tooth, the depth of the enamel, the greater width of this tooth over the type specimen tooth, and the manner of the wear on its biting surface mark this tooth (Piltdown ii, first left lower molar) as being human and not anthropoid.

The claim that the Piltdown canine is an upper and not a lower canine in no way effects the cogency of the case for its rejection as being not human but anthropoid, for it is still curved in its root and deflected in its crown. The shape of the enamel margin at the neck of the tooth shows that it is a lower and not an upper canine.

To sum up: the Piltdown remains have hitherto been accepted only as anomalous, anomalous because the head form is almost modern and the brain case, although of low elevation, indicates a considerable mental superiority over the other early fossils of Java and Pekin, with which it was considered as contemporary: and anomalous because of this chimpanzee jaw which had been *proved* to have belonged to it. It is for you to judge whether the case has been proved. There is not the slightest doubt in my mind, nor should there be much room for doubt in yours, that the Piltdown lower jaw is fossil chimpanzee.

Telephoning Fish

By Professor J. P. Frolov.

The author of this article, a pupil of the late Professor Pavlov, has been continuing his work on conditioned reflexes. The ingenious treatment of fish by electrical methods has produced remarkable results and indicated a promising line for future research.

It is pleasant to sit, on a quiet summer evening, and catch fish in the quiet water of a sleepy river. It is not unpleasant to eat the fish you have caught, dissecting their "anatomy" with a fork. It is far more difficult to study the specific features of various species of fish by observing them in a zoological museum. But the most difficult of all is to study the habits and capabilities of fish without taking them out of their natural element.

In this respect, the physiology of the brain of the higher vertebrates provides far greater convenience for the investigator. You cannot rouse a cold-blooded fish to excitement by burning its skin. But the fish is not entirely without means of expression. Experiment shows that it notices and reacts very acutely to all changes in its environment. Watch its eyes—they move animatedly, turning upwards or downwards according to the object under observation. It is true that the object itself, owing to the peculiar construction of the lens of a fish's eye, appears to it to be somewhat flattened. No one can deny the "expressiveness" of the gaze of a hungry pike when it is watching a small fish. We also know that fish have a very highly developed sense of smell, and are able to distinguish, by a sense of taste, the presence of various chemicals which water contains. Experienced fishermen declare that fish have also a sense of hearing, although no organ of hearing has ever been discovered in a fish. Nevertheless, a wily fisherman never talks while he is fishing.

The apparatus registering the movements of the fish.

A very valuable means of investigating the sense of hearing in fish is the physiological method of conditioned reflexes, a method which, in the researches of Pavlov, has helped to bring to light many aspects of the activity of the brain and sense organs in animals and human beings.

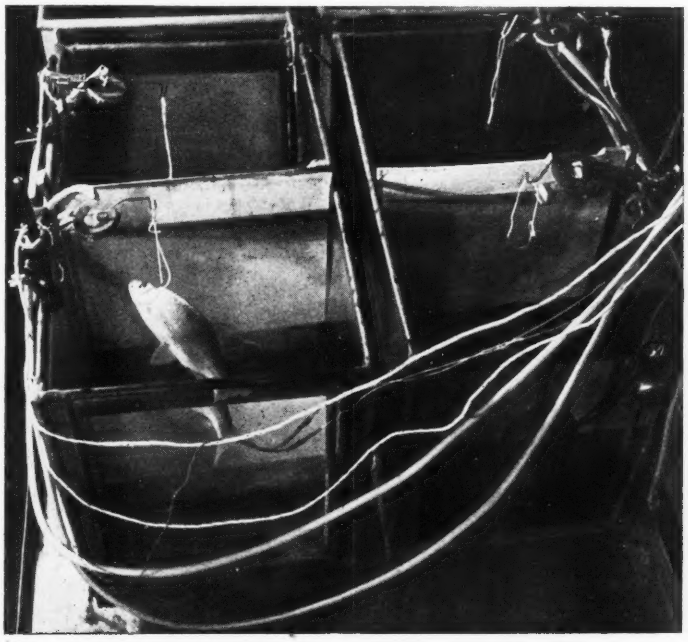
I was personally very anxious to test this new method in settling the vexed question of the hearing capacity of fish. This was all the more intriguing as the problem under consideration was not so much whether fish can hear as whether fish are, in general, capable of forming complex associations in their comparatively undeveloped brains, in which, moreover, the chief cellular layer in the cortex of the hemispheres, the so called anterior brain, is absent. Thus, in beginning my experiments on fish, I felt that I was at the very source of a higher nerve activity. And in truth the fish turned out to be splendid subjects for our experiments. It was as though nature itself had performed an experiment on the brain of the lowest vertebrates, depriving it of significant parts. It was thus possible for us to determine whether a living creature, when presented with a more or less complex task, could manage without the most highly developed sections of the brain, replacing their activity by inferior formations.

We did not, of course, conduct our experiments in natural water basins, after the fashion of the old monks, who used to call the carp in the fish ponds to dinner

and supper with a bell, for we were concerned with the reactions not only of fresh-water fish but with representatives of marine fauna, which cannot be studied so easily in their natural conditions.

We decided to construct for our experiments a special electrified aquarium in which we could produce various sounds. We set up, also, a special system of signals by which we could judge how a fish was acting even without looking at it. It may be emphasised that the majority of previous investigators took little pains to secure the complete isolation of the fish. We began by taking an ordinary telephone membrane and soldering it into a thin metallic sheath. We could lower this instrument into the water or raise it at will, lifting it above the surface of the aquarium. In order to register the movements of the fish, we used a specially constructed "fishing line," which, however, possessed neither hook nor float. Taking the fish marked for the experiment, we passed a thin silken thread through the openings of the gills, and, fastening it at the back, released the fish once more into the aquarium. We attached the other end of the thread to a small instrument known as a Murrey capsule, resembling a rubber ball filled with air and pressed to a metal plate. A long rubber tube connected it with an automatic recording device. Any movement made by the fish pulled the thread and thus drew out the base of the capsule and rarified the air in it. This in turn caused the writing point of the register to move downwards and record the movement on the ribbon of a revolving drum, as can be seen from the curve in the illustrationon p. 18.

We found that all fish, without exception, when placed in these somewhat artificial conditions, rapidly grew used to their new surroundings and remained completely calm, in spite of a partial restriction of their movements.



The wiring of the aquarium. The current passes through the tank, and therefore through the body of the fish.

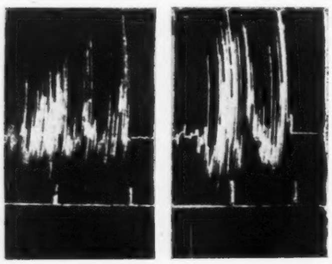
It now remained to establish a connection between a sound stimulus in the aquarium and definite movements on the part of the fish. In other words, we had to bring about a *conditioned reflex* in the fish; to create an association between a sound stimulus and a motive reaction. We were consequently faced with the difficult task of establishing a common language with the fish, utilising telephone signals for this purpose.

But what provokes movement in a fish? Naturally, only those things which help it to obtain food or to escape danger. These requirements form its instincts, or, to use Pavlov's expression, its unconditioned reflexes. For a start, we decided to use an electric current of moderate strength. We passed this current through the aquarium and, therefore, through the body of the fish, causing it to make an instinctive movement of a sharp, defensive character. Everyone knows from experience that, if he touches a live electric wire, especially with wet hands, he will get a sharp shock which makes the hand jerk away. A fish, whose body is covered by thin scales, is very sensitive to an electric current. In our experiment, the current was led directly to the scales near the head of the fish by means of a light, metallic hoop. Thus the apparatus attached to the fish was simultaneously a conductor for the current and a means for transmitting signals showing the movements of the fish.

We found that it was comparatively easy to secure a distinct reaction or habit of responding to the sound of the telephone when this sound, produced under water, was reinforced by a brief electric shock. When a connection was established in the brain of the fish

between the sound and the action of the current, we were able to repeat the experiment without the help of the current. In this way the fish was induced to respond with the same sharp movement as soon as the membrane of our telephone began to vibrate.

We began to raise the telephone gradually towards the surface of the water, not forgetting from time to time to accompany it with an electric shock. At length we took it entirely out of the water and left it hanging in the air over the surface of the aquarium: the fish continued to make the same movements in response to the sound, although the latter was being produced not in the water but in the air. Thus our task was accomplished. Although the construction of the organs of a fish is such that it cannot hear a sound directly as a vibration of the air, it is quite able to distinguish sounds if they vibrate the surface of the water with very small and rapid oscillations.



Two typical curves showing the movements of the fish.

The experiments here described formed the subject of our report at the International Physiological Congress in Stockholm. They were repeated by O. Bull (at the Marine Biological Station at Plymouth, England), and all the main conclusions were confirmed. Bull, however, did not use an electric current as the unconditional stimulus in his experiments, but the reaction of fish to food stimuli. It was found that fish are not only able to distinguish such small differences as the warmth of the water with an accuracy of 0.1° C., but can also notice the slightest change in the saltness of the water. One of our associates, S. Kirillov, tested and confirmed the experiments of Bull and showed that it is equally possible to register the movements of fish swimming freely in search of food and the movements by which fish take their food (worms) into their mouth.

Le Play Society.

During the Christmas vacation a visit of the Le Play Society to Brussels is arranged, under Mr. W. A. Riley, Exeter, with Miss E. Whalley, M.A., as hostess. During the week from January 5th to 12th a Study of that city will be made from the point of view of its history and social organisation. For full particulars write to Miss Margaret Tatton, Director, The Le Play Society, 58, Gordon Square, London, W.C.1.

Submarine for Measuring Gravity.

An expedition sent out on November 30th by the U.S. Navy Hydrographic Office to measure the force of gravity in the Caribbean is to undertake the 6,500-mile journey in the submarine *Barracuda*. The chief organiser is Associate Professor Richard M. Field, of Princeton University Geology department, who in a recent announcement described the major objective as "measuring the force of gravity in the region where the great West Indian archipelago bends toward South America, in what is suspected to be one of the greatest deformations of the earth's crust and in which there are frequent volcanic eruptions and many earthquakes." Since the variations in the force of gravity are greater in the proximity of archipelagoes than anywhere else in the world, it is expected that the data to be obtained will throw important light on many fundamental geological problems.

Variation in the force of gravity indicates variation in thickness or density of the earth's crust. Data obtained in the expedition will therefore have direct bearing on the theory of isostasy and various theories of mountain-building, not to mention the question of the earth's exact shape. The Caribbean was selected because it lends itself so readily to research.

An Improved Chronometer.

The expedition on the *Barracuda* will make use of a crystal clock, placed at its disposal by the Bell Laboratories of New York, which, it is expected, will increase the accuracy of the gravity observations and will be an improvement upon the chronometer methods previously employed. A multiple-pendulum apparatus, invented and constructed by F. A. Vening Meinesz of the Netherlands Geodetic Survey, a pioneer in underwater gravity measurements, will also be used.

A submarine is essential in establishing gravity stations because it can reach quiet waters below surface disturbances. The delicate instruments used cannot be operated on a surface vessel at sea even in calm weather. For the establishment of a gravity station, the submarine is submerged seventy-five feet. The process of making gravity readings occupies about forty-five minutes. At the conclusion of the scientific work, the submarine is brought to the surface again and proceeds to the site chosen for the next gravity station which may be seventy-five miles away.

Simultaneously with the opening of their Electric Illumination Exhibition last month, the Science Museum, South Kensington, have issued a handbook entitled *Electric Illumination*, by W. T. O'Dea (H.M. Stationery Office, 6*d*.), a concise survey, copiously illustrated with plates and diagrams, of the basic factors influencing the illumination engineer to-day.

Preserving a Roman Kiln

By Currah Crawhall, M.Sc.

Science Museum, South Kensington.

All those concerned in the discovery and preservation of the Roman pottery kiln here described are to be congratulated on a fine piece of work. The keen observation of the farmer on whose land it was found, the ingenuity and craftsmanship of the local workers, the ready assistance of the county museum authorities, and the persevering skill of the Science Museum staff, were combined in a first-class feat of co-operative practical archæology.

A POTTERY kiln in an almost perfect state of preservation dating back to the time of the Roman occupation of Britain, is a recent addition to the National Collection at the Science Museum, South Kensington. Although a few kilns of the period have been uncovered in the past fifty years, their discovery is comparatively rare, and it is fortunate that it should have been possible to preserve this one intact for the benefit of all to see. The story of its discovery and removal is full of interest and goes back to the time when Mr. Kenneth Chapman, the owner of Woodrows Farm, Compton, near the pleasant old village of Aldworth in Berkshire, observed, when ploughing one of his fields, a small patch of soil slightly darker than the remainder. On examination he discovered a few pieces of broken pottery. He took them to the Newbury Museum and Mr. W. E. Harris, the assistant curator, realising the importance of the find, consulted Brigadier-General W. K. Hardy of the Research Committee of the Newbury Field Club, who later, when investigations had begun, enlisted the aid of Mr. W. A. Smallcombe, Curator of the Reading Museum.

The kiln standing out from the wide trench that was dug around it, before being provided with its protective concrete jacket.

The field, of about 90 acres, slopes from the 500 ft. to the 400 ft. contour and overlooks the dried-up bed of the River Pang, south of the East Ilsley-Pangbourne Road. A 60 ft. trench dug north and south revealed nothing, but was of interest in showing that there was a depth of soil of only seven inches above solid chalk and that the plough line had penetrated to five inches From the centre of the trench another trench was dug due east; for the first 30 ft. nothing unusual was to be seen, but then, at first indeterminate and afterwards becoming more certain, an occupation level began to appear, consisting of a mass of black soil, fragments of pottery and bones of domestic animals, two inches thick at first and gradually increasing in thickness until at 40 ft. from the commencement of the trench the layer reached a maximum depth of six inches. At 60 ft. the ground returned to normal. A short cross trench, dug northwards from the richest part of the deposit, located what subsequently proved to be the stokehole of a kiln.

The kiln was carefully uncovered, but was found to have been considerably damaged, probably before it had been abandoned. Three coins were discovered, from which it may be assumed that the kiln was in use up to 400 A.D., an assumption supported by the type of pottery found. No structural remains were found except a circle of flints round a hole of six inches diameter, which may have been a posthole. Apart from broken pottery, about 1 cwt. in all, the only other relics were a few nails and a broken stylus.

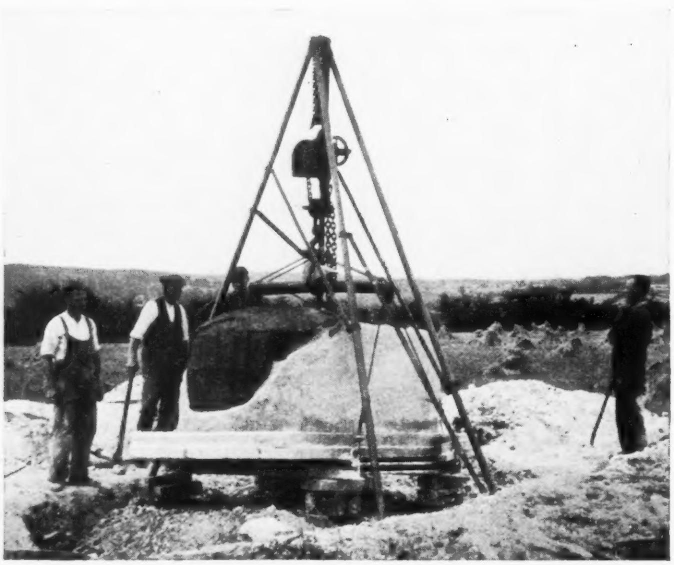
While this work was going on, an area about 100 to 200 yards east of the damaged kiln, where Mr. Chapman's curiosity had first been aroused, was ploughed. As already mentioned the chalk is only two inches

below the plough line and it was therefore a comparatively simple matter to examine a very considerable area in a short time by the simple expedient of turning over the subsoil with a garden fork at intervals of six feet. Half-an-hour's work led to the discovery of an occupation level and after a further hour the stokehole of the kiln which is now at the Science Museum was located.

It is natural that the kilns would be situated near to a settlement because of the difficulty of delivering the fragile pottery over long distances, but attempts to locate any settlement were unsuccessful. On such ground it is doubtful if any trace would remain. Although the surrounding district is all now under cultivation—the kilns were in a field of oats during the excavation—there is no doubt that in former times the neighbourhood was heavily wooded. Timber in large quantities would be necessary for fuel and would consequently have a considerable bearing on the selection of the site. Clay exists nearby in a number of small pockets, but is quite abundant about a mile away—the present farm buildings stand on an outlier of the Reading beds.

The kiln occupied one end of an oval hole, about 16 ft. long by 6 ft. wide, dug in the chalk to a depth of approximately 4 ft. The walls were made roughly of clay and stones, while just below the upper level of the chalk was a floor of clay, three inches thick and about 3 ft. diameter, on which the pots were stacked for baking. Heat from the wood fire below passed through a number of holes in the floor which was supported by a short vertical wall running from the centie to the back of the kiln. During the firing period the pots would be covered over by a dome-shaped temporary cover of clay and straw projecting above ground level, with a hole in the top through which the smoke would escape. Small portions of this dome have been found in the vicinity. The only other things of interest, both difficult to explain, were a large stone on the left of the stokehole outside the kiln—a similar stone was found on the right of the stokehole of the damaged kiln although stones of such size are not to be found in the neighbourhood—and a trench about one foot wide and nine inches deep in the chalk running along the whole of the northern edge of the kiln and the stokehole: this trench may possibly have been the fiduciary line used in laying out the kiln or the pots may have rested on it before they were placed in the kiln. An interesting fact is that the centre lines of both kilns are almost exactly on the same East-West line. A coin of Commodus (181-183 A.D.) was found not far from the kiln and from the fragments of pottery a number of pots have been reconstructed by the Reading Museum.

Mr. Smallcombe suggested preserving it for the nation, and the Science Museum was approached. It was at this point that the wiiter became associated with the work.



The tripod lifting-tackle ready to hoist the kiln on to the lorry. The kiln itself is concealed within the concrete jacket.

A wide trench had been dug in the chalk surrounding the kiln to a depth of about a foot below the stokehole level. The upper floor was supported by tightly packed earth and a concrete wall was built across the mouth of the kiln and separated from it by sacking. On account of the friable nature of the walls a small amount of chalk had to be left on them and round this was built a concrete jacket reinforced by expanded metal and pieces of scrap iron. The most difficult task of all and the one which introduced the greatest risk of damage was the undercutting of the floor. By working a little at a time and keeping the kiln continuously supported on pieces of timber it was possible to construct a complete wooden floor separated from the kiln by about two inches of concrete in order to ensure a level support and so to reduce the risk of breakage. Below the wooden floor were placed two strong steel girders, with holes in their ends for lifting and separated from one another by steel bars to form a rigid cradle.

Neither the kiln nor the concrete jacket suffered as much as a crack on its journey to London and there it will remain for posterity to see in a realistic representation of its original surroundings.

Before lifting the kiln by tripod and tackle an estimate had to be made of the weight, but the exact weight (just under $4\frac{3}{4}$ tons) was not known until London was reached. By this time the oats had been cut and the kiln was rolled clear of the hole on metal rollers. Higher and stronger lifting gear had to be brought from Thatcham before the load could be lifted on to a lorry. The lorry, specially selected to give the minimum of vibration, undertook the journey at night when the roads were comparatively free from traffic. The additional precaution was taken of proceeding at a speed of from 10 to 15 miles per hour. In the Museum the kiln has been placed in the Lower Galleries, adjoining the Children's Gallery, where a difference in floor level of nearly four feet has made it possible to give it a natural appearance. A mural painting by E. M. Dinkel, imaginative of the local scenery in the early centuries of the Christian era, provides a suitable background.

General Hardy.

Since this article went to press, we have heard with deep regret of the sudden death of General Hardy, a week after he had attended the opening to the public of his greatest discovery. The loss to archæology, especially of the Roman period, is a great one.

(*Continued from the next column*)

material things it strives to interpret. As such it has at least a super-material quality, and possesses a "Free Will" which, in the ordinary sense of the word, can hardly be supposed to depend on the apparently indeterminate nature of material things.

If indeterminacy has contributed anything towards religion, it has only done so in showing the very definite limitations of science in explaining natural phenomena, thus exploding the 19th century belief that science could ultimately explain all things.

Religion as an inherent belief in a Supreme Being is far older than science; it has played a fundamental part in the history of humanity, and it would be poor faith to mould our religious beliefs on science, which deals (or should deal) only with the material side of things, and is forever in a state of flux. Who can say that a new era in science may not see the downfall of indeterminacy? Should this happen, unlikely though it now seems, would it be pertinent to enquire whether all serious minded scientists would then abandon the religion they have so newly adopted?

Yours faithfully,
J. A. C. Teegan.

Bath, Somerset.

Correspondence

GUARDIANS OF THE BIRDS

To the Editor of Discovery.

Sir,—Many of your readers who are bird-lovers may be pleased to hear of the formation of a new society whose principal aim will be to put an end to the destructive practice of egg-collecting. The society, the name of which is the Association of Bird Watchers and Wardens, already has many members, but many more are required if this aim is to be fully realised.

In the length and breadth of these islands there must be many bird-lovers who spend their spare time round our estuaries and reservoirs watching birds and studying their habits. To the great majority of these the idea of egg-collecting is repugnant, and it is to these that we appeal to join our Association. This does not mean that they will be required to spend their time watching certain nests to see that they are not robbed, but that, when they are out on their bird-watching expeditions, they will keep their eyes open and do their best to protect the lives and eggs of our wild birds, and also report to head-quarters any case of egg-collecting that comes to their notice.

We are not planning to have our own bird sanctuaries with watchers to protect them, as this work is already being carried out with great success by the R.S.P.B. but we hope by voluntary effort to make the whole of the British Isles one vast bird sanctuary.

Yours faithfully,
N. Tracy.
Hon. Secretary,
The Association of Bird
Watchers and Wardens.

South Wootton,
King's Lynn.

INDETERMINACY AND RELIGION.

To the Editor of Discovery.

Sir,—It has become fashionable with modern Scientific writers to assert that the principle of "Indeterminacy" according to which physical phenomena no longer rest on a scheme of determined laws, is in some way or other a sort of proof in favour of the existence of Free Will. Surely this inference is a little far-fetched? Unless Free Will, and the working of the mind in general, are to be attributed to the mere whims of the atoms comprising the highly specialised form of matter in the human brain. Whilst indeterminacy is a welcome reaction from the rigid materialism of Haeckel, it loses much of its value in this sense, when the apparent determinism of material things is employed as an argument in deciding questions of our belief or disbelief in the existence of God.

When one reads that "religion first became possible for a reasonable scientific man following Heisenberg's work in 1927," it might be asked what such religion implies? If it means belief in the indeterminate nature of things, the statement is intelligible, but if it implies belief in the existence of a supernatural power it becomes entirely meaningless. The indeterminacy of physical phenomena has led scientists to stress the importance of mind, which interprets nature, rather than the

(*Continued in the previous column*)

Inaudible Sounds

By Major R. Raven-Hart

The scientific and industrial potentialities of "ultra-sounds," those air vibrations which are too rapid for the human ear, have so far progressed little beyond the experimental stage, except in certain well-defined directions. Major Raven-Hart not only describes some recent practical applications of these waves, but suggests a possible solution by their agency to some hitherto insoluble mysteries.

It would be difficult to conceive of anything more suggestive of entire uselessness than sounds which no one can hear, sounds of a pitch above the normal range of the human ear; and yet these "sounds" are already being used commercially, and are likely to have applications of an importance at which we can merely guess to-day.

Everyone knows, I suppose, that if the pitch of a sound is raised steadily there comes a time when not everyone can hear it: quite a number of people, especially older people, cannot hear the squeak of a bat, for instance. The limit varies for different ears, but it is likely to be about 16,000 cycles per second: very few can hear 20,000. Even 16,000 is pretty high: top C on a piano is about 2,000, so that this is about three octaves higher than that note.

The "inaudible sounds" used commercially are more than another octave higher still, usually about 35,000-40,000 cycles a second, so it is safe to say that, humanly speaking (using the word "humanly" in its literal sense), they are inaudible.

Now, before these sounds can be used, not only have they to be produced, an easy matter by several methods, but also an artificial "ear" that can appreciate them has to be provided. One method of producing them, perhaps the most satisfactory, is to employ the piezo-electrical effect in quartz. When a quartz crystal is subjected to an electrical voltage it changes its shape; when anything changes its shape it disturbs the air (or whatever else it is in) around it; when air is thus moved it in turn moves the air near it; such disturbances in the air, therefore, propagate outwards, at a known speed, losing strength as they travel; and if, before they become too weak, they reach some moveable object, they move this object—the membrane of the ear in the case of ordinary sounds, for instance.

Recording Oscillation

If we connect a wireless valve to a suitable arrangement of condenser and coil and source of voltage we can make the circuit oscillate: that is to say, we can change the direction of the voltage in it rapidly. "Rapidly" means a hundred million times a second if we wish—such rapidity is actually used in wireless—so that 40,000 times a second is mere child's play. We need then merely to put our quartz crystal in this circuit so that these rapid changes of voltage reach it, and "sounds" of 40,000-cycle pitch will be sent out into the air (or whatever it is) that surrounds the crystal. These are *not* wireless waves: such waves are not carried by the air as are these, and cannot be detected by the human ear directly. We need only to slow these oscillations down (by increasing the size of the condenser, for instance) to, say, 10,000 a second, and our ear will at once tell us that the crystal is sending out *sounds*, whether we can hear them at the high speed or not.

A Crystal "Ear"

Fortunately, these crystals work also in reverse; if they are pressed out of shape they produce a voltage. Here is, therefore, the "ear" we need: we have merely to put a second crystal where it will be attacked by the moving air from the first one, and it will produce such a change of voltage for each air-wave that reaches it. The rest is easy: we have only to amplify these voltages, just as in a normal wireless receiver, and, when they are large enough, make them show their presence on a voltmeter or other indicating device.

One practical application is for testing castings. If one end of a newly cast long bar is tapped, thus starting a wave of movement in the bar, an ear applied to the far end would hear each tap (the moving metal at that end moving the air inside the ear and so, eventually, the membrane of it). With practice it might even be possible to detect a flawed rod because it "rang false." If, instead, we put one quartz crystal at one end and the other at the other we can *see* on the voltage indicator whether there is a flaw: the reading will be entirely different from that given on a flawless casting.

Users of the popular miniature cameras may remember that some years ago their choice lay between a fine-grain emulsion with a slow speed, necessitating a longer exposure, and a coarse-grained one that did not enlarge so well but had a faster speed. One way to get a fine grain is to keep the emulsion very thoroughly shaken while it is being formed and deposited on the celluloid: makers are now doing this shaking by putting these "ultra-sound waves" through it as it is deposited, and thus fine grain with high speed has become possible. In this case only one crystal would be needed, of course,

unless a second were added to ensure that the first was working properly and really emitting the requisite "sounds."

Echo Sounding

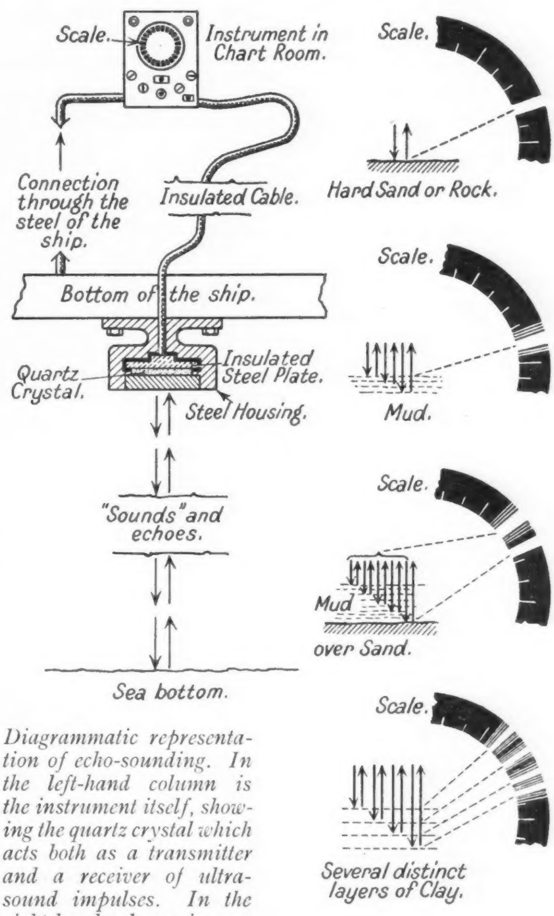
Perhaps, however, the most interesting application *at the moment* (I underline those words; and please note that I refer to the moment when these words are written, since I know that fresh developments may be disclosed at any instant, is in sounding, depth measurement for navigation. "Echo" sounding, that is, using ordinary sounds to measure the depth by seeing how long it takes for a sound to get back to the ship after being reflected by the sea-bottom, has been in practice for some time, but was never entirely satisfactory (largely because other noises, from engines and propellor for instance, confused the results): now inaudible sounds are used instead, and have the additional advantage that they can be sent out in a distinct beam vertically below the ship, and not merely more or less in that direction. Here, again, it has proved possible to use one crystal only, the same one "listening" for the sound which it has just sent out. The accuracy is striking; up to about 12 fathoms the depth can be measured to within a foot, and for greater depths up to say 100 fathoms, the error is never more than a fathom. Far more exact measurements could indeed be made, but these obviously suffice for all practical purposes.

"Seeing" the Sea Bottom

The apparatus is so neat that it is worth describing: here, when the "sound" gets back, the voltage which it makes the crystal produce is caused to light up a tiny lamp rotating behind a transparent scale. The "sound" is sent off as this lamp passes through the zero mark: where it lights up the scale the depth can be read directly. If about ten sounds are sent out a second, the lamp, therefore, rotating round the scale also ten times a second, these ten flashes look like a steady light to the eye, and the reading can be taken more easily. And here comes in another valuable point: the bottom of the sea is rarely a solid reflector that sends back sharp echoes only. If, for instance, it is mud, the echo will be "muddy" and the light blurred: if it is hard sand the echo will be sharp, and so will the light. Further, if it is mud over sand there will be two echoes, and two lights. A practised observer can thus tell the nature of the sea-bottom from what its echo "looks" like.

In fact, and it *is* a fact, a shoal of fish will also produce an echo; and, what seems well-nigh incredible, different sorts of fish give different sorts of echoes. This fact is actually in use on fishing boats.

So much for some practical uses of an apparently useless principle. Just a hint in closing of what may prove of quite revolutionary importance: we cannot hear these sounds but many animals can (cats hate them) and many animals can also produce them. There is a delicious story of the American experimenter in this field, who was driven to distraction by foreign "ultra-sounds," which he finally traced to crickets, at such a distance that their chirps were totally inaudible in the normal range, but producing "ultra-sounds" of such volume that they spoilt his results even at that distance. This may well prove to be the solution of the mystery of how the female death's-head moth calls the males to her, and the hundreds of other problems of insect intercommunication.



Diagrammatic representation of echo-sounding. In the left-hand column is the instrument itself, showing the quartz crystal which acts both as a transmitter and a receiver of ultra-sound impulses. In the right-hand column is seen a set of scale-readings, showing the various types of light indication appearing on the chart-room scale. These are sharply defined or blurred in appearance according to the nature of the bottom.

The Food of the Shovel-Tusked Mastodon

From an American Correspondent

The rule of nature that over-specialisation leads to the downfall of the race is well illustrated by the case of the shovel-tusked mastodons, whose food source was until recently a mystery.

When a few years ago experts at the New York City Museum unwound from their protective wrappings the bones of "fossil elephants" recovered from the sands of the Gobi Desert by the Central Asiatic expedition under Dr. Roy C. Andrews, they were much puzzled by the strange lower jaws and shovel-like teeth. These differed from those of any other elephant, fossil or living, and clearly the feeding habits of the animals must have been unique.

Henry Fairchild Osborne, President of the American Museum, suggested that the Gobi elephants used their shovel-like jaws to scoop up swamp vegetation; and there the matter rested until recently, when the Swedish explorer, Sven Hedin, made important discoveries bearing on the problem while on an expedition into Northern China. On the Tien Shan foothills were found the fossil plants upon which the shovel-tusked elephants fed when they inhabited this region many ages ago.

Scattered over the sand-washes surrounding the wells in the Gobi, and reaching down with their roots to the sub-surface water, are the only trees of the desert, poplars and elms. Not tall and slender like those in the humid parts of the world, but low and bushy are these poplars and elms which to-day occupy the very fringe of the plant world in Central Asia. The size both of their trunks and their leaves is limited by the dry winds which sweep almost constantly across the plateau.

In the rocks laid down as mud and sand in the lakes of Turkestan millions of years ago—mud and sand now compacted into shale and sandstone—Norin and Bohlin, Hedin's geologists, found leaves of poplars and elms, exactly like those now living in Central Asia. These fossil leaves record the existence of desert trees in the remote past, and reveal the climate almost as exactly as though a prehistoric meteorologist had been there with his thermometer and rain-gauge. The poplars and elms of the past, like those of to-day, lived in a cool dry region.

Although stunted by the inhospitable conditions of the land, a grove of such trees is a welcome sight to travellers who have seen nothing larger than bushes for long miles and months.

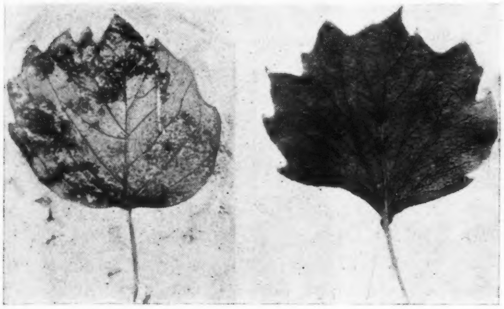
Some of the plant fossils, shipped to the laboratory of Dr. Ralph W. Chaney at the University of California, proved to represent pond-lilies, cat-tails, swamp grasses and sedges, as well as poplar and elm leaves.

Dr. Chaney pointed out that both in the Gobi Desert and in Death Valley, California, there occur, on the borders of the mountains, numerous lakes in which aquatic vegetation is present in abundance. The fossil trees of the sandy slopes,

Left: Shovel-tusked Mastodons in their native swamp: an impression by an artist of the American Museum of Natural History

Right: Jaws of the Platybelodon, or shovel-tusked Mastodon in course of excavation by members of the Central Asiatic expedition. The bones lay embedded in the hardened mud deposit of an ancient lake-bed in Mongolia.

the swamp plants of the shallow lakes, all fit into the picture of an arid inland area not unlike that of Central Asia to-day. Occurring in rocks of about the same age as those containing the fossil leaves (the latter part of the Tertiary Period), the shovel-tuskers have been



Leaf of a fossil poplar (left), compared with a present-day leaf from the Central Asian Desert. Their identity indicates a similar climate.

found in the Caucasus of Asia Minor, in the eastern part of the Gobi Desert of Mongolia, in the Mojave Desert of California, and in Nebraska and Kansas.

All of these regions, as indicated by the fossil plants and animals which have been collected in them, had an arid climate during the latter part of the Tertiary Period—a climate not suited to the growth of luxuriant vegetation of the type required for food by modern elephants. To have lived in these regions, elephants of the past must have had wholly different feeding habits. As already mentioned, their shovel-shaped lower jaws and teeth in themselves indicate a mode of securing food unlike that of other elephants. The pond-lily has tuberous underground stems several feet in length which are rich in starch. In fact the moose, largest of North American mammals, is known to feed on these stems of the pond-lily and other aquatic plants. The cat-tail and swamp grasses also have stems and roots of sufficient size to serve as food for an elephant. Here then was the food for this extinct race of beasts.

It is interesting to realise that this specialised equipment for dealing with bog vegetation probably led to the extinction of the shovel-tusked mastodon. The drying-up of the lakes at the end of the Tertiary Period resulted in the temporary elimination of this type of food, and the beasts were unable to adapt themselves to feeding upon the elms and poplars, which became the characteristic vegetation of these now dry regions.

The Panama Disease of Bananas

It seems that man, in his attempt to wrest from the soil rather more than his fair share of food, is being defeated by a new plant fungus. The plant affected is the banana. The only variety which is commonly attacked is the variety known as the *Gros Michel ;* the wild plantain and the other varieties are immune. The fungus is known as *Fusarium oxysporon,* the last name referring to the prickly spore which is very characteristic. Where bananas are grown together in large numbers the chance of infection, and the rate of spread of the disease are naturally increased. Infection of the banana can occur only through the root ; a spore alighting on a leaf is incapable of causing any disease. This is exactly paralleled by *Pythium,* which causes the "damping-off" of seedlings, and even the common mushroom is known to penetrate the roots of grasses. The hope of finding a perfect preventive seems, at the moment, very remote. A firm of commercial chemists claim that hydroxy-methyl-butyl benzene is effective in preventing germination of the spores. For their experiments they have used a banana agar, similar to that used among geneticists for their cultures of *Drosophila.* It is amusing to note that this particular chemical is the same one as introduced for preventing skin diseases, ringworm, and athlete's foot !

Art in Printing

"It must be regarded as satisfactory that our contemporaries, whose counterparts twenty years ago welcomed the cornucopia, the scrolls and the ribbons of meaningless decoration, use, in the normal course of business, the work of artists who think in terms of abstract design and other forms of graphic presentation." So writes R. B. Fishenden, Editor of *The Penrose Annual* (Lund Humphries, 10*s*.), in his review of the 1937 volume, just published.

His optimism is well justified by the work which the book includes. The frontispiece is a picture of three fish on a plate. Baird Tennant designed it, and it is printed from half-tone blocks made from a Vivex natural colour photograph. This frontispiece provides food for thought. If we can use an artist to put to paper the personality of three fish on a plate, what can we not use him for ?

L. Moholy-Nagy, an artist in colour photography, writes, "we must use the unleashed colour-photo camera in accordance with the recognised principles of black-and-white photography." The accompanying illustration of one of the artist's oil pictures on rhodoid indicates that he attaches a broader significance to this statement than might be expected.

In fashion illustration, says H. W. Yoxall, there is a reaction from elaborately naturalistic sets. An illustration of an André Durst photograph for *Vogue* presents a gown in a surrealist setting. G. C. Dandridge, however, lays down that the requirements of a railway poster are low printing cost, good typography, and maximum legibility. It is not enough to commission a good artist, he says ; he must be fitted to undertake the particular design required. But an artist there must be, and old-fashioned heavy type and ubiquitous pointing hands are no more.

Near Eastern Antiquities.

The exhibition of objects from Sir Leonard Woolley's excavations near Antioch, this year, at the British Museum, will be of great interest both to those with knowledge of early Grecian and Asiatic ware and to those who are simply lovers of the old and beautiful.

The exhibition is excellently arranged, the centre case containing the most important group of exhibits—fragments of pottery of 1700 B.C., found during a limited period of work at Atchana. These fragments show unmistakable traces of both Cretan and Asiatic influences. Never before have these two styles been found together, and Sir Leonard is of the opinion that next season's work on the same site will bring about important developments.

A puzzling exhibit is that of a Cypriote style amphora, with a design incorporating a singularly lifeless representation of a bull, and a krater, also undoubtedly Cypriote, carrying in its design a bull magnificently alive. The discrepancy between the artistic standards of the two is not easily accountable.

Some Ionian cups of the 8th and 7th centuries B.C. are of wonderfully fine fabric, and some Rhodian fragments of the 7th-5th centuries carry amusing and life-like animals and birds. A fragment of Proto-corinthian type of this period carries a male head equal in fine workmanship to anything known to-day.

A large case contains hundreds of examples of curiously shaped pots found in a "factory" at the harbour site. Here, also, a number of copper weights and iron implements were discovered. A bone statuette is a rare and interesting exhibit. In style it recalls the ivories at Ephesus. It was found at the 5th century level, but had undoubtedly originated in the 6th century, and had been kept as an antiquity. An unusual silver purse, of the 6th century B.C., contained minute silver coins, weighing as little as .6 grains, yet recognisably stamped on both sides. An interesting feature of the excavations at the harbour is that a large quantity of Attic silver tetradrachms came to light, but no large coins of Cyprus, Sidon, Aradus, etc., indicating that Athens was importing more than it was exporting, and had to pay in cash.

A series of Byzantine glazed vessels, miniature glass bottles, and glazed cups with handles, all dating from the 11th-13th centuries A.D., wound up a well-ordered and extremely interesting exhibition.

Egyptian Loan Collection

Another interesting occasion at the British Museum during last month was the opening of a temporary exhibition of Egyptian sculpture lent by Mr. C. S. Gulbenkian. Among the fine pieces displayed was a fragment of a statue of obsidian, which was obtained in ancient times in the Ægean from Melos, though it is more probable that the Egyptians obtained it from Armenia; and a head of dark granite, not often used by the Egyptians, who generally chose a warm, grey granite. The style dates this head to the time of the Middle Kingdom, about 2400-2000 B.C. It probably represents a Nubian official. A head compounded of two parts, a head-dress of blue glazed earthenware, and a face of white vitreous paste, was an interesting exhibit, having a hole in the front of the head-dress for attaching a separate, possibly golden, uræus.

A blue glazed head of a Pharaoh had the right eye of white and black glass; the left eye, now lost, had been painted in. It has sometimes been identified as Thothmes III or Amenhetep II (15th or 14th century B.C.).

There were some panels from an ivory casket. The top piece, from an end, bore the inscription in two lines "Mayest thou do the desire of thy heart . . . mayest thou do what thou desirest; tire not thereof," in hieroglyph writing of the Saite period. The four broad panels, of which three were nearly complete, showed men carrying offerings, with papyrus reeds in the background. A bronze cat with kittens, of the XXVIth dynasty or later, made a delightful subject, while an ivory toilet spoon, XVIIIth dynasty, with the handle in the form of a palm tree and two monkeys squatting on the date clusters, eating, was also unusual.

Books Received

Birds of the Wayside and Woodland. By T. A. COWARD, edited by ENID BLYTON. (Warne. 7*s.* 6*d.*)

Change in the Farm. By T. HENNELL. (Cambridge Univ. Press. 6*s.*; new cheap edition.)

A History of Fishes. By J. R. NORMAN. (Benn. 15*s.*; new cheap edition.)

Nuclear Physics. By N. FEATHER. (Cambridge Univ. Press. 10*s.* 6*d.*)

Readjustment in Lancashire. (Manchester Univ. Press. 4*s.* 6*d.*)

Recollections and Reflections. By SIR J. J. THOMSON. (Bell. 18*s.*)

Ions in Solution. By R. W. GURNEY. (Cambridge Univ. Press. 10*s.* 6*d.*)

A Creed for Sceptics. By C. A. STRONG. (Macmillan. 6*s.*)

The Measure of Life. By RAYMOND HARRIS. (Stanley Nott. 10*s.* 6*d.*)

Intermediate Chemistry. By T. M. LOWRY and A. C. CAVELL. (Macmillan. 12*s.* 6*d.*)

Modern Elementary Chemistry. By F. SHERWOOD TAYLOR. (Heinemann. 5*s.*), and *Handbook* to the above (6*s.*).

Return to Malaya. By R. H. BRUCE LOCKHART. (Putnam. 10*s.* 6*d.*)

Creative Art in England. By WM. JOHNSTON. (Stanley Nott. 21*s.*)

Recent Advances in Cytology. By C. D. DARLINGTON. (Churchill. 2nd Edition. 21*s.*)

The March of Science. (British Association Quinquennial Review). (Pitman. 3*s.* 6*d*).

The March of Knowledge

Excavations in Syria

Numerous houses solidly built in mud brick were unearthed during excavation at the Chagar Bazaar site of the British School of Archæology in Syria, reported Mr. M. E. L. Mallowan, director of this year's expedition, lecturing recently at Burlington House. In them were found 12 cuneiform tablets which awaited deciphering. They appeared to have been written at various periods between 2000 and 1500 B.C. Beneath the floors were tombs containing skeletons attended by rich offerings. Soundings at two neighbouring mounds produced material of the period between 3500 and 2500 B.C., and the evidence indicated that the Assyrians had only made a superficial penetration of this remote region.

"Peking Man" Skulls

A fifth skull, which may prove to be the most important of all, has been found at Choukoutien. The finding of two skulls of "Peking Man" was announced on November 19, and of two more on November 25. The fifth is the skull of an adult male, unique in that it has some basal parts which other skulls lack, and has in addition some facial skeleton, including eye sockets and part of the nose, which, with data available in the jaws previously found, will probably enable a fairly complete restoration of *Sinanthropus Pekingensis*.

Giant Panda

The first Giant Panda to be captured alive was taken by Mrs. Ruth Harkness, on a recent expedition into the frontier country between South-Western China and Tibet. After an adventurous journey in the company of a Chinese explorer, she located a female giant panda, which bolted, leaving a newborn cub in a hollow tree. The baby survived the severe trial of the journey to the coast and the owner hopes that it will arrive safely in America.

A Settlement of the Tripolje Culture

An important discovery of a village settlement of the Tripolje culture is announced from the Province of Kiev, in southern Russia. The discovery was made by a party of archæologists of the Marr Academy of Material Culture excavating under the auspices of the Soviet Government near the village of Khalepye. The very excellent state of preservation of many of the remains makes it possible to reconstruct in no little detail the life of the Tripolje people. The Tripolje culture, so called from the site in Southern Russia on which it was first found, has as its most characteristic feature painted pottery. It is the most westerly outpost of that great area of early painted pottery, of which evidence belonging to the neolithic and early metal ages extends from eastern Europe to western Asia, Mesopotamia, Iran and beyond to India and even China. The most informative find, however, was a large number of pottery figurines of men and women, giving an idea of the people's dress. The women wore their hair loose but tied in a knot at the end. The principal garment of the men was worn draped across one shoulder.

Bacteria Destruction

"Gunning for bacteria" is the description applied by an American magazine to a new method of electrical destruction of bacteria. A new type of lamp emitting energy in the ultra-violet region has been produced in the laboratory. The lamp is stated to have a low power input and operates only a few degrees above room temperature, so that it can be used in cooled spaces. The generation of radiant energy is highly efficient. The desired effects can be obtained with infra-red, radio-frequency or certain regions of the ultra-violet. In practice, choice is limited to the latter, since it combines low cost with moderate heating and safety in use.

New Resin Series

A new series of synthetic resins, claimed to be as clear as optical glass and to be flexible, non-shattering, and possessing remarkable chemical inertness and strong dielectric properties, is being marketed in the United States under the name "Pontalite." They are esters of methyl acrylic acid, and soften when heated, and can be sawed and machined. The use of this material for safety-glass interlayers, sound recording cylinders, dentures, telephone transmitter diaphragms, is suggested, in addition to its undoubted value for machine-turned and engraved ornaments.

Active Carbon from Coal

At the request of the War Office an investigation has been made at the Fuel Research Station with the object of producing active carbon for gas masks from British coal. The knowledge possessed by the station concerning the carbonization process and the properties of various coals has enabled successful results to be achieved after very little special work. It has been found, a recent report states, that certain hard coals (durain), with a suitable but rather critical degree of caking power, if carbonised in suitable sizes at low temperatures and then activated by steam at high temperatures, will provide an active carbon very nearly, if not quite, as good as the best obtainable from other sources, and at a considerably lower cost.

Book Reviews.

Acropolis Marbles

Archaic Marble Sculpture from the Acropolis. By HUMFRY PAYNE and G. M. YOUNG. (Cresset Press. 30s.)

I can think of no more adequate way by which the ordinary person can grasp the beauties of Archaic Athenian sculpture than by studying the plates of this admirable book; equally I know of no book so useful and enlightening for the expert archæologist on this subject. Mr. Payne, whose untimely death occurred a few weeks before the book appeared, has written the text, and included in it the results of his own researches. Mr. Young, in close collaboration with Mr. Payne, has taken the photographs. Here at last is a book which is concerned only with first-rate original Greek statues, bound for the most part to be first-rate if only because they were dedicated on the central shrine of Athens, the Acropolis. We have none of the ambiguities that surround the study of Roman copies, and all the certainty of being in touch with the authentic products of the finest artists of the most sophisticated centre of art in the 6th and 5th centuries B.C. in Greece. It is as though we were dealing with the original manuscripts of Alcæus, Sappho and Aeschylus.

That discoveries can, even now, be made in museums whose contents have been known to archæologists for forty years, is proved by Mr. Payne's attribution on grounds of style of two archaic head and bust fragmentary sculptures in French museums, to bodies long known in the Acropolis Museum, and his final proof that his attribution was right by finding that the broken parts connected in each case. Here is the one wholly convincing kind of proof that the student of sculpture can produce, and the one and only side of that study which is primarily empirical. One would have thought that the possibilities of the Acropolis Museum had been long exhausted in this respect. It is pleasant to think that every museum may still hold its surprises. Mr. Payne revises the hitherto accepted chronology of Attic sculpture and emphasises that its fullest period of development owed more to internal experiment and invention than to outside influences. He attempts to group several heads and statues and to isolate the styles of individual sculptors. In the earlier Attic period he is successful; in the later his attributions will fail to convince a majority. His general statement of the aims and æsthetic intentions of Greek artists of the archaic period is beyond praise and his æsthetic evaluation of each work is precise and informative. The book will remain a landmark in the study of Greek sculpture.

S. CASSON.

The Distribution of Life

Plant and Animal Geography. By MARION I. NEWBIGIN. (Methuen. 12*s.* 6*d.*)

As a rule zoologists and botanists live in watertight compartments, and know too little either of the principles upon which the others work, or the difficulties with which they have to contend, but in this interesting and important book, the posthumous work of Dr. Marion Newbigin, whose death two years ago was a great loss to biogeography, they can meet on common ground. Each will look to see whether the objects of their studies confirm the views which they have formed upon the problem of geographical distribution. For animals and plants have been exposed to the same influences, animals being ultimately dependent upon the vegetal cover; and though both have come in contact with the same barriers, there are notable differences between the results, as they have each reacted in a different manner. To botanistsand to zoologists, consequently, the study. of geographic al distribution means something different For the botanist the limits are vaguer, the fossil record far less complete, and climate a far more decisive factor. Whereas animals enjoy a high degree of mobility denied to plants, the latter have much greater freedom of dispersal. Their seeds are far more resistant and can be easily transported across vast distances of water, which to most animals are an absolute barrier. Seeds too, no doubt, can be carried far afield by air currents, to which the higher animals are indifferent, though smaller creatures, as insects and spiders, can be carried to a degree not generally realised. Again, the diversity of plants is far greater than that of the animals, at least in the higher classes. For instance, the single family of the *Compositæ* the highest of the plants, contains more species than the mammals and birds combined. Still, making due allowance for these differences, the author is able to write that, "in the main . . . the past and present distribution of the higher plants confirms the conclusion derived from the study of animals."

Many important points of detail are emphasised, especially in the earlier chapters, dealing with the general principles affecting plant distribution. We are warned that geographers and ecologists have different points of view. The ecologist is concerned with minute details, with micro-climates, the geographer with broad principles and averages.

The author is cautious, and while giving the essentials of the theories of Suess, Wegener, and Bailey Willis, somewhat wistfully declines to commit herself to advocacy.

MALCOLM BURR.

Art and Life in New Guinea. By RAYMOND FIRTH. (The Studio. 10*s.* 6*d.*)

More than forty years ago Dr. Haddon initiated his fellow anthropologists into the mysteries and imaginations of the art of the peoples of New Guinea; but to the layman this art remained almost unknown until a few examples were shown at the exhibition of primitive art of the Burlington Fine Arts Club in 1935. Now, Professor Firth has made it more widely and comprehensively accessible by bringing together a collection of illustrations which includes over eighty representative examples. This collection is unique and as such will appeal no less to the anthropologist than to the layman.

Primitive art has been the subject of much critical discussion ever since the sculpture of tropical Africa became a formative influence in the development of modern art. In his brief but excellent dissertation on the art of New Guinea, Professor Firth indicates what to the student of culture is the only legitimate point of view. Neither the method of psycho-analysis nor the standard of modern ethics is applicable. At the level of development of the peoples of New Guinea, art is inextricably woven into the texture of the religious, social, economic, and technological complex. In general terms this might be expressed by saying that the art of any given people is a function of the culture in which it appears. The implication for the criticism of certain manifestations of modern art should be obvious. If Professor Firth's book drives this lesson home it should become a landmark in æsthetic criticism.

As to the specific purpose of the collection, it gives, so far as is possible within a compass that is limited in relation to the ground that is covered by the wide variety of subject matter, an instructive view of the different forms of art found among the groups of peoples in New Guinea. The most striking feature is the number and variety of the conventionalised designs employed in the decorative art and the artistic skill with which they have been adapted to the form and purpose for which they are employed. In sculpture, as Professor Firth points out, the work of New Guinea stands comparison with that of Africa. Bizarre as this art may seem to the unaccustomed eye, it well repays close study. The photographic reproductions are for the most part excellent.

E. N. FALLAIZE.

Verulamium: A Belgic and Two Roman Cities. By R. E. MORTIMER WHEELER and T. WHEELER, F.S.A. (Research Committee of the Society of Antiquaries. 15*s.*)

The excavation of the site of Verulamium at St. Albans and the closely related site at Wheathampstead by Dr. R. E. Mortimer Wheeler and Mrs. Wheeler marks an epoch in British field archæology; and the report on the results obtained by the four seasons' work, in the preparation of which Mrs. Wheeler shared, but of which, to the deep regret of her numerous friends and of all archæologists, she did not live to see the publication, no less sets a standard of accurate record and lucid exposition of essential detail, which every field archæologist would do well to emulate. Dr. Wheeler's style, however, his urbanity and his humour are individual; and they make his report excellent reading, even for those whose knowledge of Romano-British antiquities is not profound.

The main interest, in a general sense, of the excavations at St. Albans resides in the light they have thrown on the state of Britain, at least in this corner of the island, in the dark period immediately before the Roman invasion. Not only have they placed beyond question, so far as any doubt remained, the relatively high degree of culture of these Belgic tribesmen, but, what was not expected, they have revealed an advanced political organisation and a close economic and cultural contact with the Continent.

Dr. Wheeler has produced a vivid reconstruction of the history of the site in some detail from the material yielded by the spade. In his account we can follow its development from a Belgic stronghold at a strategic point, menaced from the north, through its history as a Roman settlement both in its period of magnificence, when it was dignified with the title of *municipium* (of which no other city in Britain was thought worthy), and in its decay, until the time when, after a brief renaissance, it was finally left derelict. In the light of such a story it is not surprising to find that many of the structures brought to light by Dr. Wheeler and his band of helpers are unique in Britain. Absorbing, however, though the description in detail of these may be, it is Dr. Wheeler's brilliant archæological synthesis which will most strongly impress the mind of every reader, and to which he will return again and again.

Chemical Discovery and Invention in the Twentieth Century. By SIR WILLIAM A. TILDEN. Sixth edition, revised by S. GLASSTONE. (Routledge. 15*s.*)

First published in 1917, this book was originally intended for non-technical readers. A perusal of succeeding editions, however, has shown that its scope has widened considerably, with the inclusion of many features appealing more especially to those who have a good knowledge of science. New material appearing in the present edition is mainly concerned with chemical works laboratories, theories of atomic structure and of the union of atoms, transmutation and disintegration of the elements, artificial radioactivity, the discovery of "heavy hydrogen," vitamins, hormones, etc. About fifty new photographs and a number of new biographical notices are also included. The chapter entitled, "Laboratories and their Uses" is especially interesting, as it contains lengthy descriptions of laboratories under the control of large commercial corporations and government institutions. A succeeding chapter on "Apparatus" is of particular interest for the general reader who may wish to know something of weighing operations, methods adopted for heating and cooling, the production of a vacuum, and electrolysis.

Inorganic Chemistry. By NIELS BJERRUM. Translated and adapted by R. P. BELL. (Heinemann. 7*s.* 6*d.*)

In his foreword to this book, Professor F. G. Donnan, of the University of London, states that it is the finest introduction to modern chemical science that he has read. We agree with him, for we have never previously read a text-book on inorganic chemistry for review purposes so pleasurably. One of its novel features is its treatment of the modern generalised theory of acids and bases and the associated subject of ionisation and reaction in solution, an advance that owes its origin and development to the work of the Danish school of physical chemistry. Practical aspects and applications of chemistry and theoretical developments are interwoven in a truly harmonious manner and

(quoting Professor Donnan) the translated text "reads as smoothly as if it had been written originally in English—and, what is more, in good English." The general plan is to divide the book into four sections—atomic theory, non-metals, light metals, and heavy metals. "The metals fall naturally into two groups: the light metals with densities below four and the heavy metals with densities above seven," we are told. This statement makes us ask: are there no metals with densities *between* four and seven? If not, is not some explanation to be offered? Apart from the occurrence of a number of mis-spellings which have escaped the proof-reader (*e.g.*, page 76, Kipps apparatus for preparing *cases*) there are few other comments to make.

School Certificate Chemistry. By A. HOLDERNESS and J. LAMBERT. (Heinemann. 4*s.* 6*d.*)

The joint authors of this book are of the opinion that one of the major problems of the teacher of chemistry is to ensure the availability of adequate material for the pupils' revision. They have, therefore, made an attempt to overcome such a problem by giving very full descriptions of all the experimental work involved. As a departure from the usual School Certificate textbooks they group the metallic compounds by the acid radicle and not by the basic radicle. In addition, they give extended reference to the atomic and molecular theories.

Inorganic Chemistry: A Survey of Modern Developments. By Sir GILBERT T. MORGAN and FRANCIS HEREWARD BURSTALL. (Heffer. 15*s.*)

Inorganic chemistry, considered apart from organic chemistry, has again become the source of many epoch-making discoveries, just as it did in the days before organic chemistry had properly evolved as a science. Noteworthy recent additions to our knowledge of the chemical elements and their derivatives are here presented in a readable manner, showing that inorganic chemistry has often been sadly neglected by research workers in favour of organic chemistry. For instance, to find an appropriate parallel to the discovery in 1933 of the isotope of hydrogen and the existence of "heavy water" as a normal constituent of ordinary water, we have to go back as far as 1894, when atmospheric air was found to contain chemically inert gases not previously recognised or even suspected. Similar comparisons are recalled in other aspects of the inorganic field by the nineteen chapters of this book, which has a commendable feature in giving the discoverer's name and year of discovery for each salient new fact which is mentioned, rather than full references to the literature of chemical research—thereby avoiding any tendency for the general reader to be unnecessarily wearied.

North Australia. By C. PRICE CONIGRAVE. (Jonathan Cape. 10*s.* 6*d.*)

This book might well have been very good. In fact, it is merely mediocre. The facts are there: everything one could wish to know about North Australia, past and present, is there, but buried; buried under a mass of irrelevancies, verbosity and bad grammar. There are anecdotes in plenty; the author is writing about experiences he himself has undergone; but, except in the chapter dealing with the incompetent and irascible old Governor of Escape Cliffs, Colonel Finniss, the vital touch of life is missing. The pictures are interesting, though few. This work, viewed as a serious text book to North Australia, a region not overdone in literature, has many points. But for the less serious lovers of adventure and travel it is not recommended.

The Place-Names of Warwickshire. By J. E. B. GOVER, A. MAWER and F. M. STENTON, in collaboration with F. T. S. HOUGHTON. English Place-name Society, Vol. XII. (Cambridge University Press. 21*s.*)

Shakespeare's county, on the evidence of its place-names, which have now at last been carefully analysed, proves to be thoroughly Anglo-Saxon in origin, with little trace of the earlier Britons or of the later Danes. It was evidently colonised from the west by the Saxon tribe of Hwicce and from the east by the Angles, who formed the kingdom of Mercia. The Hwicce, when christianised, had their bishop at Worcester, while the Angles looked to Lichfield for guidance. Thus Warwickshire was divided between the Worcester and Lichfield dioceses, and the boundary marked the original frontier between Saxon Hwicce and Anglian Mercia. A field-name, Martimow, in Radway parish, is traced back to the "Mercna merc" in an Anglo-Saxon charter of Kineton, abutting on Radway to the west. Now Radway is in Lichfield diocese and Kineton in Worcester, and "Mercna merc" is evidently the "boundary of the Mercians." Thus an obscure field-name, rightly interpreted, throws light on the political condition of Warwickshire in the 7th century. Place-name study is always yielding such interesting results.

The editors have recorded on a little map the recurrence of names with the suffix "leah," clearing, and "(ge) haeg," hedge or enclosure. Almost all of them occur in the country to the north of the Avon. Dugdale, in the 17th century, knew that part of Warwickshire as "the Woodland," while the district south of the Avon was "the Felden," or open land. The place-name evidence shows that "the Woodland" had been gradually settled by hardy Anglo-Saxon pioneers. It was, in fact, the great Forest of Arden, which in the middle ages had its own "law" and almost touched Cannock Chase to the north and Charnwood Forest to the north-east. Shakespeare must have known it well; the Arden which he made the background for *As You Like it* was no imaginary forest. The name, like that of the Ardennes, which Cæsar knew, derives from a Celtic "ardu," high or steep. Birmingham, probably "the home of the people of Beorma," was one of the early settlements in Arden. Deritend, "the deer-gate end," and Solihull, "the muddy hill," recall the woodlands in which they were founded.

The permanent influence of the Roman roads is well brought out. Watling Street was and is for many miles the county boundary towards Leicestershire. The Fosse Way, crossing the county from south-west to north-east, serves as a boundary for numerous parishes. Stratford was the ford where a Roman road crossed the Avon, on its way to Alcester on the Ryknild Street. Shottery, the Anglo-Saxon "Scotta rith" or building-stream, perhaps took its name from ruins beside the Roman road. Other derivations of interest that may be noted are, Warwick, Anglo-Saxon "Walrinc wicum," or dwellings by the weir; Coventry, Cofa's tree; Kenilworth, Cynehild's farm;

and Rugby, "Hroca's burh," which Scandinavian intruders from Leicestershire modified into Rokeby or Rugby. The curious name, Mancetter, for the Roman-British Manduessedum, is made up of the obscure "Mandu" and "ceaster" or camp. An instructive note on "The Folly" as a place-name suggests that it was often, if not always, a nickname for a building that had cost too much or proved to be useless; a rival theory, that "folly" here is akin to foliage and suggests a country house seems to lack proof. The general editors, Dr. Mawer and Professor Stenton, and their colleagues are to be congratulated in having dealt with ten counties and the North Riding—almost a fourth of their task.

E. G. HAWKE.

Scientific Progress (*The Halley Stewart Lecture*, 1935). By Sir JAMES JEANS, Sir WILLIAM BRAGG, and Professors E. V. APPLETON, E. MELLANBY, J. B. S. HALDANE and JULIAN HUXLEY. (Allen & Unwin. *7s. 6d.*)

In this book Sir James Jeans deals with "Man and the Universe," telling us that the universe may be more like the untutored man's commonsense conception of it than had seemed possible a generation ago. In his review of the "Progress of Physical Science," Sir William Bragg throws himself eagerly into the task of trying to interpret the world in which we find ourselves. "Electricity in the Atmosphere" is the subject chosen by Professor E. V. Appleton, who states that there are still many unsolved problems providing work for future investigations. Professor E. Mellanby gives an outline of progress in medicine and medical science through the centuries; as regards the accession of new knowledge, he points out that the pace is quickening and facts are accumulating faster and faster. "Human Genetics and Human Ideals," by Professor J. B. S. Haldane, and "Science and its Relation to Social Needs," by Professor Julian Huxley, complete the six chapters, which will appeal to an extremely wide circle of readers.

The Student's Manual of Microscopic Technique, with Instructions for Photomicrography. By J. CARROLL TOBIAS. (Chapman & Hall. 10*s.* 6*d.*)

This book gives some very useful information which will enable the student to prepare his own material, without undue failure, for microscopical examination. The methods described for making satisfactory slides have been tested in the author's laboratory, using equipment which is also described and illustrated. The accompanying photographs are remarkably clear and appear to be just the type needed to assist the text rather than provide an embellishment. Following a chapter on microscopic objects from water, the technique of killing, fixing and preserving, dissociation, section cutting, and staining are discussed. Separate chapters are added to deal with the preparation and mounting of hard objects (such as bone, teeth and coal), and general methods for preparing animal and vegetable material. There are also chapters on the polarising microscope and microscope accessories, and a very practical discussion on means for attaining success in photomicrography. Apart from filling a real gap among books devoted to the microscope, this book can be highly commended to all who possess a microscope either as a hobby or for professional use.

The Squirrel's Granary. A Countryman's Anthology. By SIR WILLIAM BEACH THOMAS. (Alexander Maclehose. 7*s.* 6*d.*)

This anthology is different from all others that have attempted to cover the same subjects. It provides prose and verse which we should not expect to find; the pieces so often gathered together by the anthologists (with perhaps half-a-dozen exceptions) have been wisely left uncollected because we already know where we may find them if needed. Like the squirrel, Sir William Beach Thomas has been intent on gathering a richer harvest of infinite variety, so that we may turn the pages in much the same spirit and with the same expectancy that we turn the corner of a lane in some part of the country hitherto unvisited. Our love for the country may be centred in birds, beasts or insects; in wild flowers or country cottage gardens; in scenery, with which sky, sea and seashore are so closely associated; in the changes which characterise the seasons, months, and day and night; or in England as a country, where we may still wander far more free of hindrance than abroad—to serve each choice there is the appropriate section in this anthology. Even "some naturalists" have not been overlooked, and each section is provided with an introduction so original in thought and so happily in keeping with the selected prose and verse that it could easily be mistaken for one such item.

Literary Originals of Sussex. By G. and R. THURSTON HOPKINS. (Alex. J. Philip, Gravesend. 2*s.*)

This book forms the first volume of a series—"Literary Originals of the Counties," which presumably the present authors intend to compile. It will appeal to a limited audience—those fanatically interested in Sussex and to the keenest of literary pilgrims—unnecessarily limited because of the arrangement of the work; it is composed entirely of indexes. The main section of the book contains an alphabetical list of persons, places and things in Sussex which appear in the literature of the county under assumed names, together with the titles of the books which introduce real places under imaginary place names. There is much that is original in the book, and there is this to be said for its arrangement: it avoids the wordiness and pomposity of many previous books dealing with literary originals. But although the detailed nature of the research done results in a scholarly effort, surely such scholarship is misplaced!

It is interesting to know that such and such a place mentioned in a book has its real counterpart, but not so interesting as to make anyone wade through several indexes with multitudinous cross-references; especially when an arbitrary alphabetical division is adopted. The ordinary educated man welcomes information about specific places or people such as this work gives, but he would prefer the arrangement to be either topographical or according to the different authors. He emphatically is not interested in a higgledy-piggledy conglomeration of isolated facts.

Stone Age Africa. By L. S. B. LEAKEY. (Oxford University Press. 7s. 6d.)

Dr. Leakey has expanded his Munro Lecture for 1935-6 into a small book, in which he summarises current knowledge of the Stone Age in Africa. He has thereby conferred a signal boon on those who have not had the opportunity of following the somewhat intricate detail of recent research.

It is unfortunate that the progress of prehistoric archæology in the Stone Age is becoming increasingly difficult for the layman to follow. In Africa matters are further complicated by the local terminology which has been adopted, with good reason be it said, by the archæologists of South Africa. Dr. Leakey himself enters a plea for a terminology that is more generally applicable; and the method which he himself has followed in his researches in East Africa, in which he essays what is more or less a middle course, is an example of what can be done, given precision in defining terms. In this book, however, in which he attempts a general survey, he is constrained to make the best of a difficult business. Notwithstanding his difficulties he has succeeded in bringing both the North and the South African Stone Age into intelligible relation with East Africa, where the research of Mr. E. J. Wayland in Uganda and his own work in Kenya have produced a logical classification, which reduces the facts to order, even if the detail may afford matter for argument.

When this much has been said, it is unnecessary to stress the fact that the most interesting and informative section of the survey deals with East Africa. M. Vaufrey's recent epoch-making analysis of the cultures of North Africa receives full credit; South African Stone Age industries and the art of the bushmen are described or discussed with discrimination; but in East Africa the author is on his own ground and dealing with his own material. That his results have in certain respects become the subject of acute controversy is unfortunate; but even when every discount is allowed, their importance is unquestionable. Mr. Leakey has not hesitated to put the issue fairly before the reader, though quite honestly expressing the view that he anticipates the final verdict to be in his favour.

Short Notices

The Birds of Tropical West Africa. Vol. 4. (D. A. BANNERMAN; The Crown Agents for the Colonies, 22s. 6d.) contains an account of the first eight families included in the Passeriformes. It includes 435 text-figures, and fourteen full-page coloured plates, of excellent quality. The volume follows the same plan as the foregoing three, and contains a very useful "Illustrated Key," with drawings by Mr. Henrik Grönvold.

At the Zoo (JULIAN HUXLEY; Allen & Unwin, 3s. 6d.) carries on Professor Huxley's work as Secretary of the Zoological Society of London by making the Zoo interesting even to those who regard it as no more than an entertainment for children. The simple concise talks on biology are easy to follow, and the chapters on the Colours of Animals and on Animal Reproduction are especially enthralling. The book is a most suitable gift for nature lovers of all ages. In the reprint which it is certain to have it is to be hoped that the "*Anthropods*" mentioned in the last chapter will receive their proper spelling.

The Clear Mirror (G. E. HUTCHINSON; Cambridge Univ. Press, 8s. 6d.) describes itself as "a pattern of life in Goa and in Indian Tibet. The pattern, impressionistically treated, is, not surprisingly, confused and intricate in the oriental manner; yet the author succeeds in conveying the idea of the repeated motive appearing and reappearing in unexpected surroundings. The "clear mirror of religion" reflects diverse pictures in the same way, whether the subject is a mouldering Renaissance church in Goa, or a lonely *chorten* on the Upper Indus; and the observation of plant, insect, and fresh-water life achieves the pleasing meticulousness of a Chinese drawing.

Strange Sea Shells and their Stories (A. HYATT VERRILL; Harrap, 10s. 6d.) makes no attempt at scientific classification, but recounts in a chatty way a number of miscellaneous facts concerning sea shells and their inhabitants. It is directed, in the main, towards a youthful American public, and its American readers, with two oceans and several climates at their front door, so to speak, can investigate for themselves many of the wonders related. A useful chapter dealing with the Shell Aquarium will appeal to those whose interest in conchology is not purely academic.

Apes and Monkeys (E. G. BOULENGER; Harrap, 7s. 6d.) is a popular review of all "named" apes and monkeys of the past and the present, and of the various habits which characterise each species. It is excellently illustrated, and contains many amusing anecdotes. The author is Director of the Zoo Aquarium, and most of his stories concern the London Zoo.

Animal Lover (GERVASE LAMBTON; Witherby, 5s.) introduces the reader to the strange collection of pets kept by the author on his father's estate in Bedfordshire, which he manages. They include a donkey, a monkey, llamas, goats, Shetland ponies, a young yak, a honey bear, a family of kangaroos, a mongoose and a cockatoo. It will be read with great interest by all lovers of animals, and with profit by any whose affection takes the practical turn of keeping unusual pets.

Scrambles Among the Alps (EDWARD WHYMPER, revised and edited by H. E. G. TYNDALE; Murray, 10s. 6d.) presents that classic of British mountaineering, already republished five times since its first appearance in 1871, in an extremely palatable form, with all the old woodcut illustrations, a number of photographic plates, and a gravure frontispiece of Edward Whymper. Large-scale maps of the various districts are appended at the end.

With Scott to the Pole (HOWARD MARSHALL; Country Life, 5s.), a short book of 47 pages, tells its story simply, adding nothing new of narrative or comment. The thirty-odd full-page photographs, prepared from those taken during the expedition, are by far the best feature of the book.

Methuen's monographs on physical subjects have lately been augmented by *Electron Diffraction* (R. BEECHING, 3s.), *Mercury Arcs* (F. J. TEAGO and J. F. GILL, 3s.), *Thermionic Emission* (T. J. Jones, 3s.), *Infra-Red and Raman Spectra* (G. B. B. M. SUTHERLAND, 3s.), and *Distillation* (J. REILLY, 3s. 6d.). Each contains numerous diagrams, and is clearly printed.

Libraries for Scientific Research in Europe and America (H. PHILIP SPRATT; Grafton and Co., 10s. 6d.) consists of a detailed description of the history and facilities of libraries, specialised and otherwise, all over Europe and Russia. The Science Museum in London receives a whole chapter for its library, and this book should be a great saver of time and labour for research workers.

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